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THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE
PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE
SCIENCES AND THE ARTS.

CONDUCTED BY
ROBERT JAMESON,

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New Publications received—To be noticed in our next Number.

1. Explication de la Carte Géologique de la France, rédigée par MM. Dufrénoy et Elie de Beaumont. Tome deuxième, 4to. Paris, 1848.

2. Humboldt's Cosmos. Translated, with the Author's sanction and co-operation, under the superintendence of Lieut.-Colonel E. Sabine, R.A., For. Sec. R.S. Vols. I. and II. Longman, Brown, Green, and Longmans, Paternoster Row; and John Murray, Albemarle Street, London, 1849.

3. Wilson's Jussieu's Elements of Botany. John Van Voorst, Paternoster Row, London, 1848.

4. A Monograph of the British Naked-eyed Medusæ, with figures. By Edward Forbes, F.R.S., &c., &c. Printed for the Ray Society. London, 1848.

5. An Introduction to the Birds of Australia. By John Gould, F.R.S. 1848.

6. The Gold-seeker's Manual. By David T. Ansted, M.A., F.R.S. John Van Voorst, London, 1849.

7. On the Nature of Limbs; a Discourse delivered at the Meeting of the Royal Institution of Great Britain. By Richard Owen, F.R.S. John Van Voorst, London, 1849.

8. A Tour in Sutherlandshire, with extracts from the Field-books of a Sportsman and Naturalist. By Charles St John, Esq. In two volumes, with woodcuts. John Murray, Albemarle Street, London, 1849.

9. Professor Scheerer upon Polymeric Isomorphism.

10. The Journal of the Indian Archipelago and Eastern Asia. Nos. 9, 10, 11, 12. Singapore: Printed at the Mission Press.

11. Transactions of the China Branch of the Royal Asiatic Society. Hong-Kong: Printed at the office of the China Mail, 1847.

12. The Ethnological Journal. Several numbers received.

13. Essai sur la Végétation de l'Archipel des Féroë, comparée à celle des Shetland et de l'Islands Meridionale. Par Ch. Martins.

14. Journal of the Asiatic Society of Bengal, up to August 1848 inclusive.

15. Bibliothèque Universelle de Genève, up to August 1848 inclusive.

16. Lectures on the Study of Chemistry. By John Davy, M.D., F.R.S., &c. 291 pages, 12mo. Longman, London, 1849.

17. Address to the Members of the Berwickshire Naturalists' Club for 1848.

ERRATA in No. LXXXVII.—JAN. 1848.

Page 44, line 13, for partly, read pretty—P. 45, l. 28, for firmness, read fineness—P. 47, l. 23, for waters, read ureters—P. 47, l. 2 (note), for semiluna, read semilunar—P. 47, l. 3 (note), insert the before epiglottis—P. 47, l. 7, 12, 13 (note), for water, read ureters and ureter—P. 49, l. 7, for inhalation, read exhalation—P. 49, l. 20, for vegetable, read notable

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

The Life and Writings of Louis Agassiz, Doctor of Philosophy and Medicine, LL.D. of Edinburgh and Dublin, Knight of the Order of the Red Eagle of Prussia, formerly Professor of Natural History in the Academy of Neufchâtel, now Professor of Zoology and Geology at Cambridge, in the United States of America, &c., &c., &c.

THE Agassiz family is of French origin, and were among those Protestants whom the revocation of the edict of Nantes obliged to leave France.

The immediate ancestors of M. Agassiz fled to the Pays de Vaud, which, at that time, made part of the Canton of Berne. From the time of their establishment in their new residence, their prosperity has been uninterrupted. The branch to which our naturalist belongs has been especially devoted to the ministry; the whole line for five generations have been clergymen. The father of Agassiz was pastor at St Imier (one of the Protestant parishes of the ancient bishopric of Basle, which had been just incorporated into the French empire), when he married the younger daughter of a physician of the Canton de Vaud, Mademoiselle Rose Mayor, a young lady as remarkable for the vivacity of her mind as for her beauty. They had the misfortune to see their first four children die one after the other, and the family seemed in danger of becoming extinct, when there was born a fifth son, who has become the eminent man of whose life and labours we propose to give some account.

LOUIS AGASSIZ was born on the 28th of May 1807, exactly a century after the birth of Linnæus. From his birth he

was the object of an unbounded tenderness, and surrounded by all the care which the most watchful solicitude could suggest to parents alarmed by the loss of four children. Fearing the influence of the severe climate of St Imier, the pastor Agassiz had just left this parish to take charge of one in a village in the canton of Friburg, called Mottier, situated on the peninsula of Vully, between the Lake of Neuchâtel and the Lake of Morat. It was here that Agassiz was born. Here, on the borders of the beautiful lake, at the foot of a hill covered with rich vineyards, in the full view of the chain of the Alps, he passed his first years, under the vigilant eye of a mother who divined from the first the future that was unfolded in the young and ardent nature of her child.

After having received his first education in his father's house, Agassiz was placed with his younger brother at the Gymnasium of Bienne, a small town in the neighbourhood. This establishment was at that time very celebrated throughout the canton. The two brothers passed here several years, devoted almost exclusively to the study of the ancient languages. Their father, in the mean time, had left the parish of Mottier, and accepted a situation in his own canton, in the little town of Orbe, situated at the foot of the Jura. It was during the vacations which he passed with his parents, that the attention of the young student was turned, for the first time, toward the Natural Sciences. Those who knew him at that time, remember the ardour with which he made his first collections, and the delight he showed, when, on his return from an excursion, he had some new butterfly or some curious insect to show to his mother. This taste for Natural History received new nourishment, when, in consequence of a second promotion, his father was called to the parish of Concise, a large village situated on the Lake of Neuchâtel. The vicinity of the lake, which washes the garden-walls of the parsonage, opened a new field to his insatiable curiosity concerning natural objects. From this moment, his attention was especially directed to the Fishes; and, as if he had already a presentiment of the great results which he was one day to deduce from the philosophical study of these animals, he not only applied himself to the collecting of them, but

also began to inquire into their habits, their manner of life, and the characters by which they are distinguished. He took part in all fishing excursions, accompanied the fishermen on all occasions, and often went alone, with his line in hand, to pass whole days in the middle of the lake. When he came afterwards to compare the results which he had obtained with the accounts given in treatises on Natural History, he saw immediately how much remained to be done in this department, and the idea of filling this gap constantly occupied his mind.

He had now finished his studies at school. It was to be expected that, following the example of his ancestors, he would devote himself to the priesthood. But Natural History had gained too much ascendancy. His father wisely left to him the choice of a profession. He chose that of Medicine, as offering the most opportunities for pursuing his beloved studies. He commenced the study of Medicine at the Academy of Zurich, where he was most kindly received by Professor Schinz, who admitted him to an intimate acquaintance, and furnished every facility in his power for the pursuit of his zoölogical researches. From Zurich he went to the University of Heidelberg, where he devoted himself especially to the study of Anatomy, under the direction of the celebrated Professor Tiedemann. His assiduity in study did not prevent him from taking part in all the amusements of the student life, so that the Swiss *corps* chose him for their president; and long after he had quitted the University he was still spoken of as an accomplished *Bursch*, possessing the rare talent of managing with equal dexterity the rapier and the scalpel.

It was at this time that the Bavarian Government, having recently organized the University of Munich, called thither as professors the most eminent men of Germany in all the departments of science. There were brought together at that time—Oken, the celebrated zoölogist; Martius, the botanist, who had lately returned from his travels in South America, with a rich harvest of scientific materials; Schelling, the great philosopher; and Döllinger, the founder of modern Physiology. Such a corps of teachers could not fail to attract a large body of youth eager to learn. Among

others, Agassiz did not hesitate to quit the fashionable University of Heidelberg for the rude capital of Bavaria.

It is here that his scientific career commences. The four years that he passed at the new University may be counted among the most remarkable of his life. Although only a student, his already extensive knowledge of Natural History soon drew the attention of the professors, whose lectures he eagerly attended. Friendships sprung up between him and them, and the intimacy in which he lived with these chosen men resulted in an increased enthusiasm for science, as well as an extension of the field of his researches.

With Martius he studied the organisation of plants, and their geographical distribution according to climates and regions of the globe. With Döllinger (in whose house he lived) he penetrated into the sublime mysteries of the formation of animals, and their development during the embryonic period. With Oken he discussed the principles of Classification according to the intimate affinities of things, based on a profound study of their organization.

Finally, with Schelling, he approached those questions of the higher philosophy, which, in Germany, more than anywhere else, have, at all times, been the study of the greatest minds, namely, the relations that exist between the immaterial essence of beings, and the laws of the physical world; in other words, between Spirit and Matter. The Pantheistic theory was embraced at that time by many enlightened men in Germany; and, it is not surprising, that, supported by the results of modern science, and professed under a new and attractive form by an eminent man, who, freed from all party considerations, presented it in all its grandeur, it excited the enthusiasm of the young men who crowded round the chair of this celebrated philosopher, already prepared for the doctrine by the writings of Goethe and Schiller. Agassiz, if we are rightly informed, partook also of their opinions. It was not until afterwards, that (as we shall show directly), having commenced the study of former creations, he modified his views, and unhesitatingly proclaimed, as the result of his investigations, the existence of a personal God, the Author and Ruler of the universe.

Agassiz, as we have already said, though only a student, ranked, at this time, among the scientific men of Munich. A few young men of like spirit gathered round him, forming a small but select circle, who met to discuss scientific subjects. This society soon attracted attention; it was called the *Little Academy*; even the professors gladly took part in it; and those of the students who had the good fortune to be members of it, remember the lectures read there, as not the least instructive and interesting part of their scientific course.

Martius was then occupied in publishing his great work on the Natural History of Brazil. He confined himself to the part relating to Botany. His companion, Spix, who was to edit the Zoological portion, had just died, leaving many portions of his work unfinished. That relating to Ichthyology in particular, was barely sketched out. An able zoölogist was needed to reduce to order the chaos of new species and genera, and to assign to them their true places in the system. Martius cast his eyes upon his young friend Agassiz, to whom he confided the honourable task of elaborating this important part of the work. It appeared in a folio volume in Latin, with numerous plates, making part of the "Travels in Brazil." From the time of its appearance, it gained for its author the rank of an eminent naturalist.

Such occupations necessarily resulted in detaching the young naturalist more and more from his medical studies. His parents, who had already often protested against this too exclusive passion of their son for Natural History, now had recourse to an extreme measure; they withdrew the moderate allowance which they had hitherto granted him. This was a terrible blow for the young man, who found himself thus at once deprived of all means of subsistence, and obliged to renounce what was dearer than all to him, his portfolios; for his allowance had not only supplied his daily wants, but had also been applied to paying for the services of a young artist named Dinkel, whom he had remarked among the crowd of draughtsmen who fill the streets of Munich, and who, under his guidance, became one of the most skilful painters in this department.

But, like other passions, the love of science is ingenious in

surmounting difficulties. Full of confidence in himself, he applied to the bookseller Cotta, a man who united with great skill in business the most enlarged views. To him he shewed the materials he had collected for a Natural History of the Fresh-water Fishes of Europe. The beauty of the drawings, the finish of the details, and, above all, the enthusiasm of the young man, gained the heart of the old bookseller, who advanced him funds to continue and complete his work.

At the same time Agassiz, like a good son, sought to regain the favour of his parents. For this there was but one thing to be done, namely, to return to Medicine. Until now he had divided his time between his medical and his zoölogical studies; but now we may infer that he applied himself seriously to his profession, since, not long after, he presented himself as candidate for the degree of Doctor, and passed his examination with distinction. But the title of Doctor of Medicine was not enough for him. In the same year he applied for a degree of Doctor of Philosophy, which he received after a public disputation, which produced a great sensation in the literary community of Munich.

He undertook to shew that woman is superior to man. *Mens femine viri animo superior* was the theme of his disputation. Such a proposition, coming from a young man whose devotion to the fair sex was well known, could not fail to attract attention. It was received with the most various sentiments. The young applauded the irresistible arguments of the youthful candidate; puritanic conservatives, and those belonging to what is called, in Germany, the *Historical School*, thundered against these ideas as revolutionary, and calculated to subvert the order of society. The sphere of woman, they thought, should not be extended beyond the kitchen and the laundry.

After this double examination, Agassiz received permission from his parents to visit Vienna. The object of this journey was the completion of his medical studies; but on his arrival, he devoted himself again to his favourite pursuit, and was oftener to be met with at the Museum than in the hospital. Here he made the acquaintance of many distinguished

naturalists, among others of Fitzinger; and applied himself to the special study of Ichthyology.

This study, with him, was not confined to living species. He had extended his researches to the fossil kinds, and the *debris* (often admirably preserved) found in the fresh-water deposits of Oeningen, in Switzerland, had attracted his particular attention. He found that most of the species said to be identical with those of the present epoch, were different, and therefore had drawings made of a great number; so that when he returned to Switzerland, his portfolio contained almost as many fossil as recent species. What was he to do with all these materials? His parents having already made great sacrifices for him, and seeing no guarantee for the future, were impatient for him to begin his medical career. In this conflict of his tastes and his filial duties, his position was difficult.

But he had not yet seen Paris, and he could not make up his mind to commence practice, without having examined the rich collections of that great capital,—without having visited the Jardin des Plantes; and, above all, without having heard Cuvier, whose renown filled the world.

But how was he to find means to go to Paris? His parents were neither able nor willing to contribute anything towards it. Fortunately, a neighbouring clergyman, a friend of his father, who had always entertained the highest opinion of his talents, having just inherited a small sum of money, thought he could not employ it better than in aiding the project of his young friend.

On his arrival in Paris, Agassiz lost no time in seeking out the two most eminent men of the age, then residing in that city—Cuvier and Humboldt.

Cuvier, in order to assuage his grief for the death of his daughter, had just commenced his great work on Fishes, and received with eagerness every thing concerning fossil species. Agassiz relied upon his portfolio for his introduction to the great naturalist. Cuvier was so much astonished by it, that after a second interview, he informed Agassiz, that he would give up the projected publication, and make over to him all his materials, if he would undertake to describe them. For

those who know the value which the materials for a literary work acquire in the eyes of an author, this incident of itself will be sufficient proof that Cuvier's moral character was equal to his intellectual power. From this moment Agassiz continued on intimate terms with Cuvier's family, until the death of that great man; and we have heard him say, that the happiest moments of his life were passed in Cuvier's cabinet.

After the death of Cuvier (1832), Agassiz returned to Switzerland, hoping to obtain a professorship in some of the public establishments of the Canton de Vaud. Being disappointed in this, he accepted the invitation of some citizens of Neuchâtel, to establish himself in that city, where they were preparing to reorganize the college. He was soon after appointed Professor of Natural History, a place which he filled until his departure for the United States.

Alexander Von Humboldt—who has enjoyed the rare privilege of being able to assist so many men of talent—was from the first the devoted friend of Agassiz; and it was his patronage that enabled our naturalist to commence in 1833, so soon after his arrival in Switzerland, the publication of his great work on Fossil Fishes, which he dedicated to Humboldt, and of which we intend to say a few words, as of all his works this made the greatest sensation; and it is this that obtained for him the eminent rank which he now holds in the scientific world.

This work consists of five volumes, with an atlas of about four hundred folio plates, and comprises descriptions and figures of nearly a thousand species of fossil fishes. All the specimens are represented of the natural size, with the colours of the bed from which they were taken. It was impossible that so many new species should be made known without rendering many alterations necessary in the science of Ichthyology; new types were established, and the affinities of various groups and families to each other more clearly shown. Moreover, Agassiz did not confine himself to establishing a vast number of species, genera, and even families. Besides this, he founded an entirely new classification, based principally on the importance of the fossil fishes.

Cuvier makes two general divisions among Fishes, the Osseous and the Cartilaginous Fishes. Agassiz also separates the Osseous fishes from the Cartilaginous, of which he makes his first order that of the Placoïdians; but he divides the Osseous fishes again into three other equally important orders; so that the class of Fishes is divided into four orders; namely, 1. The Placoïdians; 2. The Ganoïdians; 3. The Ctenoïdians; and, 4. The Cycloïdians. This classification is not founded on the skeleton, like that of Cuvier, but on the nature of the outward integuments, the scales. Agassiz starts with the principle, that the outward covering of fishes is the reflex of their internal organisation. With this principle, he examines the different families of the class of fishes, with respect to their scales, and finds in the conformation of the external integument a variety of characters on which he founds his classification. As to this, it is to be remarked at the outset, that all the osseous fishes, with the exception of a few genera, are furnished with horny scales; while the skin of the cartilaginous fishes is covered with plates or spines of a peculiar form, known under the names of *shagreen*, &c. The scales of the Osseous fishes are constructed on a totally different plan, and the differences are so marked, that M. Agassiz considered them a sufficient foundation for his three orders of Cycloïdians, Ctenoïdians, and Ganoïdians. The two former, which comprise almost all the Osseous fishes of the present epoch, both have horny scales; but they differ in this, that the Ctenoïdians have the posterior edge of the scales indented, while in the Cycloïdians this border is entire. He seeks to prove, that this distinction, apparently insignificant, is, in truth, founded in nature, being the expression of a fundamental character which reveals itself equally in other parts of the body. Thus, fishes having indented or pectinated scales, have generally prickles on the head, the opercula, and various parts of their body; while the others, the Cycloïdians, are smooth and without defence. M. Agassiz considers the perch, with the analogous species, as the type of his order of Ctenoïdians; and the family of the carp, salmon, pike, &c. as typical of the Cycloïdians. This division corresponds,

therefore, to a certain extent, with Cuvier's division of fishes into Acanthopterygians and Malacopterygians.

The second order, that of the Ganoidians, seems to have a yet more satisfactory foundation. There have been found in the Nile and in the rivers of North America, two fishes which have always puzzled the ichthyologists; that of the Nile is known under the name of Bichir (*Polypterus Bichir*); the other, which is found in America, is called the Garpike (*Lepidosteus*), having some resemblance to the Pike. Both these fishes are furnished with scales of very peculiar form and structure. Instead of being arranged in the manner of roof tiles,—as in most fishes,—they are placed simply side by side, the surface being covered with a coat of enamel, making a very solid cuirass. On examining these fishes in an anatomical point of view, M. Agassiz found that the skeleton presented no less striking differences than the scales and the soft parts of the body. Nevertheless, it seemed hazardous to separate them altogether from the other great families; and, particularly when the smallness of their number was considered, it seemed contrary to all method to place them in the same rank with the Placoidians on one side, and the Osseous fishes on the other. But the procedure, though not authorised by the study of the living fishes, was justified by an examination of fossil species. Here is displayed a whole ichthyological fauna, having the characters neither of the Osseous nor of the Cartilaginous fishes, but altogether analogous to the Bichir and the *Lepidosteus*. So that these two genera, apparently mere exceptions in the present creation, in reality constitute a type by themselves, which, though not numerous at present, is, nevertheless, the expression of an entire order of things. Associating with these fishes the numerous fossil species whose scales have the same structure, M. Agassiz made his division of Ganoidians, which already contains many hundred species, and promises to become still larger, since it predominates in all the formations anterior to the chalk. M. Agassiz recognises several distinct families of this order: the two principal ones are the Sauroïdians, to which the *Lepidosteus* and the Bichir belong;

and the *Lepidoidians*, which were inoffensive, and probably omnivorous fishes, somewhat resembling the Carp in appearance, but having no representatives in the present creation.

These researches among the fossils had not a geological interest alone. The numerous examinations that M. Agassiz was obliged to make, in order to establish, in all points, the analogy of extinct species with living types, revealed to him anatomical relations of great interest, which had been hitherto passed over. He thus discovered the important fact, not before made known, that there exists a remarkable parallelism between the development of the individual, and the development of the whole class in the series of ages. In the early stages of embryonic life the vertebral column does not exist. In place of it there is found, in the embryo, a gelatinous mass, called the dorsal cord. Around this cord (which remains for a longer or shorter time in all fishes) are formed the vertebræ, as bony rings. These rings gradually increase, and encroach more and more upon the dorsal cord, which, in most fishes, at last disappears. In some types, however,—for example, in the Sturgeon,—it remains during the whole life, so that this fish has no vertebræ, and the apophyses rest immediately on the dorsal cord. Now, Agassiz shows us that this is the case with all the fishes of former epochs. They all have distinct spinous apophyses, often very strong and completely ossified, but they show no trace of separate vertebræ; whence he concludes that these organs were wanting, and that the dorsal cord continued throughout life, as in the Sturgeon. As to the relative superiority of living types, also, embryology reveals to us a wonderful parallelism. There is no fish, however imperfect, whose organization does not correspond to some place in the life of more perfect types. Take, for example, the lamprey, or that still more imperfect fish known under the name of *Amphioxus*, or *Branchiostoma*, which Pallas placed among the Snails, from its great dissimilarity to ordinary fishes. The former has, in place of the cranium, only a cartilage corresponding to the base of the skull; and the latter is deprived even of this, and the dorsal cord extends to the end of the snout. The first has a single fin, more or less divided; in the other, the fin extends along

the whole body. Finally, neither has jaws, properly so called. Now, the most perfect of our fishes, such, for example, as the Salmon, are all, at one period of their life, at the same point of development, but with them it is a transient state, a stage of growth; whilst in the others it is the permanent condition.

These views have a high philosophical bearing, particularly in their application to other classes of the animal kingdom. It is in accordance with them that Agassiz determined the rank to be assigned to the various families of fishes, according to their organisation.

It is to Geology, nevertheless, that the greatest profit is derived from these discoveries. In comparing together the fishes found in various formations, Agassiz, from the first, had also thrown new light on the relative age of these formations. Thus, to cite but a single example, he was enabled by the study of the fishes of the slate of Glaris, to demonstrate that this deposit, which had previously been considered as belonging to the most ancient sedimentary rocks, the greywacke, is much more recent, and forms a part of the cretaceous group. Another and more general result of his labours was the discovery, that not only are all the fossil species different from those now living, but also, that from one formation to another, the species are equally distinct; and this diversity, according to him, is not confined to the larger formations, but exists equally between the various stages of the same formation. Thus, he recognises no species as common to the lias and the upper Jura limestone; to the upper and lower cretaceous deposits; to the ancient and recent strata of the tertiary formations, &c. The necessary deduction is, that the whole creation has been renewed at different epochs, by a direct intervention of the Creator. Agassiz, however, did not stop here, but pushed his conclusions still farther. From the fact that certain basins, like certain regions of the earth's surface, are inhabited by species peculiar to them, not found elsewhere in deposits of the same age, he inferred that each creation was local, that is to say, that species were created in the localities they inhabit, and that to each was assigned a limit, which it does not pass so long

as it remains in its natural condition. Man alone, and those few species that are associated with him, are exceptions to this general law; and, as the migrations of even these species take place under the direct influence of man, we may conclude that they were unknown to former epochs.

These considerations, with others not less important, concerning the relation which this localization bears to the temperature and degree of elevation of continents at different epochs, suggested to Agassiz some general reflections, with which he closes his chapter on Classification, and which we transcribe, as shewing the spirit in which this work is written. "Such facts," says he, "loudly proclaim principles which science has hitherto left untouched, but which the researches of palæontology urge upon the observer, with an ever-increasing force; those, I mean, that respect the relation of the Creator to the universe. We see phenomena closely connected in the order of succession, yet without any sufficient cause within themselves for the connection; an infinite diversity of species, without any material bond of union, so grouped as to present the most admirable progressive development, in which our own species is involved. Have we not here the most incontestable proofs of the existence of a Superior Intelligence, whose power alone has been able to establish such an order of things? The methods of scientific investigation, however, are of such strictness, that what seems to our feelings a matter of course, we cannot admit, unless supported by numerous and well-established facts; on this account, I have delayed expressing my convictions on this subject until the last moment; not that I have wished to avoid the discussions which the announcement of such results must necessarily excite, but that I have been desirous not to provoke them before establishing for these results a purely scientific foundation, and supporting them by rigid demonstrations, rather than by a profession of faith. An acquaintance with more than fifteen hundred species of fossil fishes, has taught me that species do not pass insensibly into each other, but that they appear and disappear unexpectedly, without showing any immediate connection with those preceding them. For I do not think that any one can seriously

affirm that the numerous types of Cycloidians and Ctenoïdians, which are almost contemporaneous, are descended from the Placoïdians and Ganoïdians. This would be, in fact, to say, that Mammalia, and thus Man, are directly descended from the Fishes. All these species have a fixed time of appearance and disappearance ; indeed, their existence is limited to a definite period. Nevertheless, they present, in their general character, affinities more or less close, and a definite co-ordination in a given system, intimately connected with the mode of life of each type, and even of each species. More than this, in all ages, an invisible thread runs through this immense diversity, presenting to us, as a definite result, a continual progress in this development, of which man is the end, the four classes of vertebrated animals the intermediate steps, and the invertebrata the constant accessory accompaniment. Have we not here the manifestations of a Mind as powerful as prolific ?—the acts of an Intelligence as sublime as provident ?—the marks of Goodness as infinite as wise ?—the most palpable demonstration of the existence of a personal God, Author of all things, Ruler of the universe, and Dispenser of all good ? This, at least, is what I read in the works of the creation, in contemplating them with a grateful heart. Such feelings, moreover, dispose us better to fathom the truth, and study it for itself ; and it is my conviction, that if, in the study of the natural sciences, these questions were less avoided, even in the sphere of direct observation, our progress would be generally more and more rapid.”

It is not astonishing that such results, accompanied by views so wide, and presented with the irresistible force of a profound conviction, gained for their author the respect of the scientific world. Learned societies vied in shewing their sympathy with him ; and (a distinction then unparalleled) at the age of thirty-four, Agassiz was a member of every scientific academy in Europe.

England was, at that time, in advance of all other nations in the study of Geology. It was here that Agassiz found at once the richest materials and the greatest encouragement. Whole collections were put at his disposal, and he obtained in this manner many precious specimens. Some of his friends

recollect, with pleasure, the impression produced by his visit on the naturalists of the United Kingdom. Several universities were desirous of numbering him among their professors, and the cities of Edinburgh and Dublin, besides conferring on him the degree of LL.D., enrolled him also among their citizens. We learn that his personal influence induced several persons of high rank to engage in the study of Natural History—among others, Sir Philip Egerton, and Lord Enniskillen, whose collections are known to all palæontologists. He became intimate with the most influential persons in the kingdom: he was the welcome guest of Sir Robert Peel and Lord Egerton, and the friend of Buckland, Owen, Murchison, and other distinguished English naturalists.

Having obtained from the study of Fossil Fishes results so important to the history of the development of the whole creation, Agassiz naturally sought to confirm them by the study of other classes of animals, and accordingly applied himself to the examination of the Mollusca and the Echinodermata. The latter had been, in general, somewhat neglected by naturalists; the fossil species, in particular, were scarcely known, although from their great variety, and the complicated structure of their shells, they are of great importance in determining the age of various deposits.

In a short time he had collected a considerable number of species, belonging to various public and private collections throughout Europe, and in 1836, he published, in the first volume of the *Memoires de la Société des Sciences Naturelles de Neuchâtel*, a Prodrômus of the class Echinodermata—the principles of which have since been generally adopted. The same volume contains another paper, giving descriptions and figures of the fossil Echini belonging to the Neocomian group* of the Neufchâtel Jura. A year afterwards, he published, in another periodical (*Memoires de la Société Helvétique*), descriptions of the fossil Echini peculiar to Switzerland. In the same year appeared the first number of a more extensive work, having the title of “*Monographies d'Echi-*

* A formation belonging to the lower greensand, near Neufchâtel, from the Latin name of which city it derives its name.

nodermes." This number contained the monograph of the *Salenice*, small Echini belonging to the chalk. It was followed by three others, treating of the *Scutellæ*, the *Galerites*, and the anatomy of the Echinus,—the last number edited by M. Valentin. To facilitate the study of these curious animals, so important to the history of successive creations, Agassiz made casts in plaster of all the specimens in his possession. This collection comprises casts of nearly five hundred species, the counterparts of which are to be found in the great museums in Europe, and has thus become one of the most precious documents we possess concerning this class of animals.

The labours of M. Agassiz on Fossil Shells are not less important. A young Swiss geologist, M. Gressly, had made a considerable collection of fossil shells from all the stages of the oolitic and cretaceous formations. M. Agassiz commenced the publication of them in a work, entitled "*Etudes Critiques sur les Mollusques Fossiles du Jura et de la Craie.*" Of this, four numbers have appeared, with a hundred quarto plates, comprising the group of the *Trygonice*, and that of the *Myæ*. At the same time Agassiz published a German translation of Buckland's Geology, with numerous notes and additions, and revised the French and German translations of Sowerby's Mineral Conchology.

But whatever may be any man's ability and energy, nature has fixed certain limits to what it is possible for him to accomplish, which he cannot pass. Thus, in order to explain the rapid succession, at so short intervals, of the works we have mentioned, and those of which we have yet to speak, we must observe, that about this time (1837), Agassiz associated with himself a young naturalist, M. Desor,—who has ever since laboured with him and under his direction, and who having accompanied him in all his alpine excursions, and in his visit to this country, is now living among us. To the information personally furnished by M. Desor, as well as to his writings, we are indebted for much of the present sketch, which would not have been written without his assistance.

The united labours of the two friends accomplished what

would have been beyond the reach of a single individual, and the fruits of these labours we see in these numerous publications.

The reputation of M. Agassiz, and his unwearied energy, transformed the little town of Neufchâtel into a nursery of science—to the great astonishment of the peaceful burghers, who, for the most part, could not at all comprehend what was going on around them. But the more enlightened among them soon gathered about him, and thus a society of Natural History was formed, that soon drew attention by its activity. The Museum, established by the liberality of some of the citizens, increased rapidly. At the recommendation of M. Agassiz, a young naturalist, a pupil of his, M. Tschudi, —since known by his work on Peru,—was despatched on a voyage round the world, to collect objects of Natural History.

The influence which Agassiz exercised was not confined to the town where he lived. He succeeded also in reviving the zeal of the "*Société Helvétique des Sciences Naturelles*," of which he was one of the directors. It was in consequence of his exertions that this society resumed with renewed vigour its publications, which had languished for some time for want of nourishment.

His studies of the Fossils did not make Agassiz forget the Fishes, which have always been, and still are, his favourites. He continued to collect materials for his "Natural History of the Fresh-water Fishes of Europe." His portfolios now contained a complete series of drawings, executed with the greatest care by M. Dinkel, the skilful draughtsman whom he had educated at Munich. Having formed at Neufchâtel a lithographic establishment in which there were several distinguished artists, he determined to commence the publication of his work. The plates of the magnificent Atlas—which justly ranks among the first works in this department,* were struck off under his eye at Neufchâtel. It is on this account only the more to be regretted, that, after having exhausted

* We may add, that, in the opinion of M. Agassiz, the execution of these plates has been surpassed only in one work, the Ichthyology of the United States Exploring Expedition.

all his pecuniary resources to make this publication worthy of its name, the author found it impossible to continue it on the plan projected. Nevertheless, science has been partly indemnified by the publication of the Embryology of the Salmon tribe, which forms the second number of the work.

After the attention which German naturalists had given to the study of this important and interesting branch of science, Agassiz determined that his Fishes also should contribute their share. He therefore employed his friend, M. Vogt (now Professor of Zoology at the University of Giessen), who, under his direction, elaborated this part of the work, which is justly esteemed by all physiologists. A third part of the same work,—the Anatomy of the Salmon,—the fruit of the joint labours of MM. Agassiz and Vogt, has since appeared in the Memoirs of the third volume of the Neuchâtel Society, with a large number of admirably-executed plates.

M. Agassiz had finished the publication of the "Fossil Fishes." But though the book was finished, the subject was not exhausted. Numerous contributions poured in from all quarters. The study of the Devonian system, in particular, had made known a whole ichthyological fauna of a peculiar character. M. Agassiz was requested by the British Association to publish these interesting remains. This he did in a First Supplement to the "*Poissons Fossiles*," under the name of the "Fishes of the Devonian System." About the same time he presented to the British Association his Report on the Fishes of the London Clay.

After the publication of the "Fresh-water Fishes," there appeared a work of a different character, and which of itself would be sufficient to establish the reputation of a naturalist. This is the "*Nomenclator Zoölogicus*,"—an enumeration of all the genera in the animal kingdom, with an indication of the etymology of their names—of the authors by whom the names were proposed—their date of publication—and the family to which they should be referred.

From the commencement of his career Agassiz had been struck by the disorder that pervaded zoological nomenclature, and the confusion resulting from the application of the same name to totally different animals. To remedy this difficulty

he prepared registers, in which he entered the names of all the animals as they occurred to him in his studies. After having continued this practice for more than ten years, he arranged the names methodically, and published the nomenclature of each class separately, after having it revised by the naturalists most distinguished throughout Europe in each special branch. "The *Nomenclator Zoölogicus*" is preceded by an introduction in Latin, in which the general principles of nomenclature are profoundly discussed, and it has become an authority universally acknowledged. In connection with this work we must mention another publication, more extensive and not less important—the "*Bibliographie Générale d'Histoire Naturelle*;" which grew up in a similar manner by the side of the *Nomenclator*. It contains a list of the authors cited in the former work, with bibliographical notices, and is in course of publication at the expense of the Ray Society. This work will form several large volumes; the first numbers, containing a list of the publications of scientific institutions, have recently appeared.

We now come to speak of a series of discoveries which have particularly tended to make the name of Agassiz known to the public in general, and from which resulted his Glacial theory. This theory is so generally known, that it may be interesting to relate, in a few words, its origin, and the different phases in which it has appeared. Although now of so wide application (extending to the whole northern hemisphere, as far as erratic boulders and polished rocks are found), its origin is to be sought in the Alps. It was among the chamois-hunters of the Valais that the idea arose, that masses of rock were transported to a distance from their original position by the glaciers. These men, accustomed to live in the high regions of the Alps, and seeing every year enormous masses of rock transported to a distance from their original positions by the glaciers, found no difficulty in supposing that *all* the boulders which are found in the valleys had been transported thither in the same manner; and as they had observed the *oscillation* of the extremities of the glaciers,—that is to say, their advance in one year and their recession in the next,—they concluded, in like manner, that,

at the period when the blocks now found at a distance from the glaciers were first detached, the glaciers themselves must have reached farther than at present.

These notions, however, had not extended beyond the limits of the Alpine valleys; M. Venetz, an engineer of the Valais, was the first to undertake an application of them, in a treatise on the subject, in which he shewed that, at various periods, since the end of the last century, the glaciers had extended farther than at present, and, in retiring, had left everywhere heaps of stones and large rocks as marks of their presence. Afterwards, M. de Charpentier conceived the idea of extending the application of these facts beyond the region of the present glaciers. He advanced the hypothesis, that the distribution of the boulders which are scattered over the valley of Switzerland* and on the sides of the Jura, may be accounted for in this way. This opinion, which he expressed in a brief treatise, was received with almost unanimous incredulity; so generally adopted was Saussure's theory, which accounted for these phenomena by the supposition that the Alpine chain had formerly been broken through at various points, allowing vast lakes, before shut up within its walls, to escape with violence.† M. Agassiz, as we hear, was among the sceptics; and, in 1836, visited M. de Charpentier with the view of persuading his friend to relinquish an hypothesis which he considered untenable. But the latter, instead of entering into a discussion, conducted Agassiz to the places themselves on the Mer de Glace, at Chamouni, where his observations had been made. He shewed him the glacier actually at work in transporting boulders, and in its passage polishing and rounding the rocks at its sides. A light now burst upon the mind of M. Agassiz; not only did he admit that the blocks found in the valley of Switzerland might have been carried thither in this manner, but he saw, moreover, at a glance, the immense bearing of this fact, and the effect it must necessarily have on the science of Geology.

* The northern part of Switzerland, between the Bernese Oberland and the Jura, goes by this name.

† For some account of Saussure's theory, see *Lyell's Elements of Geology*, American edition, vol. i, p. 245.

And indeed, in order that the Alpine glaciers should extend to the Jura, so as to deposit these blocks at the elevation of 4000 feet, the valley of Switzerland must have been covered with ice at least 2500 feet thick. Now, such an accumulation of ice could not be the effect of a local cause. The depression of temperature necessary to account for this extension of these glaciers must have made itself felt elsewhere, and this with an intensity increasing towards the north. Now, as the rocks of Scandinavia present the same marks of friction as the sides of the Alps and the Jura, accompanied also by erratic boulders, the conclusion was deduced that all the north of Europe must have been covered by a vast sheet of ice in the same manner as the polar regions are at present. The formation of this sheet-ice, in consequence of a sudden depression of the temperature, it was insisted, must have put an end to the tertiary epoch, by annihilating the animals and plants then existing.

Such was the original form of the Glacial Theory, which was first announced in a discourse of M. Agassiz in 1837, at the opening of the meeting of the *Société Helvétique*, held at Neuchâtel. The opposition excited by M. de Charpentier's theory (which only extended the glaciers of the Alps as far as the Jura) was roused in a tenfold degree by that of M. Agassiz. As is always the case when a new truth dawns upon the world, two parties were immediately formed; one embracing the new doctrine with enthusiasm, the other furiously opposing it. Disputes arose even concerning the present glaciers. It was denied that they were capable of polishing and scratching rocks. Doubts were raised as to the mode in which they advanced, and, as the very fact of their advance rested solely on public notoriety, it was demanded that their movement should be shewn by direct observations, before any conclusions were drawn from it. A problem before purely geological, was thus suddenly changed into a question of fact, requiring a long series of researches and experiments.

Though already overburdened by his various labours, Agassiz did not shrink from his task. He saw at once, that to obtain a satisfactory solution it was not enough to have such isolated observations as can be made on a short visit.

It was necessary to examine the glaciers not only at their termination, but also throughout their whole extent, to ascertain the influence of the irregularities of the soil on their movements; the temperature of the ice, and the effect of external agencies upon it, under all circumstances. In a word, it was necessary to do what had never been done before, namely, to establish an intimate acquaintance with the glaciers.

M. Agassiz, after having visited in succession most of the glaciers, fixed his head quarters at the Glacier of the Aar, whither he went for eight years consecutively with his friends, to pass his summer vacations; at first, with no shelter except a large boulder on the middle of the glacier, and which soon became famous under the name of the *Hôtel des Neuchâtelois*. Afterwards he built a little stone cabin on the left margin of the glacier; this received the name of the "Pavilion." Here he prosecuted the long series of researches that have obtained so much celebrity in the scientific world.

Although his retreat was situate 8000 feet above the level of the sea, and 12 miles from any habitation, it was soon well known throughout the country, and there might often be seen assembled a select company, in which all nations were worthily represented.

The scientific results obtained from these investigations are contained in two works. The first, published in 1840, under the title of "*Etudes sur les Glaciers*," comprises a description, with plates, of the principal phenomena connected with the glaciers, together with a detailed account of the author's views as to their former extent. The second, recently published, under the name of "*Système Glaciaire*," is the last, and seems to us likely to be one of the most successful works of the author; it contains a detailed account of the investigations made during his last five visits (from 1841 to 1845), with the view to determine the mode of progression of the glaciers in all parts of their course at all seasons of the year, and under all conditions of temperature. This work is accompanied by beautiful plates, and a topographical chart of the glacier of the Aar, on a very large scale (1:100,000), allowing even the minutest details of the surface

to be given, so that this glacier is better known, in a topographical point of view, than any canton or state.

We cannot, of course, undertake an analysis of the results obtained from all these observations, and summed up at the end of each chapter. We will only say, that this work, if we mistake not, is to be considered as a sort of introduction to a more extensive undertaking, for which the author has already collected a great number of materials, and which is to comprise the history of the last great revolutions which the earth's surface has undergone. We understand that M. Agassiz finds in this country a vast field for research, and valuable materials in the works of American geologists.

Referring those of our readers who are desirous of particular information on this matter, to the above work, we conclude our sketch with a single passage of a different character, from a little volume by M. Desor, entitled, "*Excursions et séjours de M. Agassiz, et de ses compagnons de voyage, dans les Glaciers et les hautes régions des Alps*,"* containing a lively and interesting account of the incidents and adventures of their mountain life, as well as of the topography and scenery of the country, and from which (did our limits allow) we would gladly make larger extracts. It is easy to conceive, that, living in the midst of the magnificent peaks by which the glacier of the Aar is surrounded, the temptation to scale their dizzy heights must be strong, especially when fortified by a scientific interest. M. Desor gives accounts of various ascents undertaken by their little company; the most memorable of which is that of the Jungfrau, which took place in 1841, having for its object the study of the structure of the snow and ice on the higher summits. The Jungfrau is the most admired of the Swiss mountains, and, next to the Finsterahorn, Mont Blanc, and the Monte Rosa, the highest of the Alps, being 13,720 feet in elevation. We extract from the above-mentioned work some

* Neuchâtel and Paris, 1844, 18mo. For many interesting details, among others, the account of a descent into one of the crevasses of the glacier, to examine its structure, see an article by M. Agassiz himself, in the Edinburgh New Philosophical Journal for 1842.

particulars of this ascent, which was much talked of among the mountaineers; since, by many of them, the Jungfrau was considered inaccessible. Starting from the hamlet of Mril, on the Viesch Glacier, at five o'clock, A.M., M. Agassiz and his companions arrived at two P.M. at the base of the highest summit, the inclination of which, on being measured, was found to be 45 degrees. This declivity, moreover, was covered with hard, slippery ice, in which it was necessary to cut steps; and this, together with the intense cold, so retarded their progress, that at one time they advanced only fifteen steps in a quarter of an hour. The summit formed the vertical section of a cone; and the ice being less hard at the edge of the precipice, they walked, by the advice of their guide, on the very brink of the abyss. "Several times," says M. Desor, "on thrusting out my staff rather further than usual, I felt it pass through the roof of snow,"—which, as is usually the case, projected like a cornice from the edge of the precipice,—“and then we could look (whenever the fog separated for a moment), perpendicularly through the hole into the vast gulf below.” The fog, which had hidden every thing from sight, cleared away when they reached the summit, at about four P.M. “Here, for the first time, we had a view of the valley of Switzerland; we were on the western edge of the section of the cone, having at our feet the barrier that separates the valley of Lauterbrunnen from that of Grindelwald. . . . The mountain here forms an abrupt angle, a dozen feet below the summit, and we saw, with a sort of affright, that the space which separated us from the highest point was a sharp ridge, about twenty feet long, the sides of which had an inclination of from sixty to seventy degrees. ‘There is no way of getting there,’ said Agassiz; and we all inclined to the same opinion. Jacob (their principal guide), on the contrary, said there was no difficulty whatever, and that we should all get over. Laying aside what he carried, he commenced the undertaking by passing the staff over the ridge, so as to bring it under his right arm. and thus climbed along the western slope, burying his feet as much as possible in the snow, in order to obtain foothold.” In this way he passed over, and after having re-

moved the snow from the summit, persuaded them all to follow. "The summit is a very narrow, triangular space, about two feet long, and a foot and a half wide, with the base towards the valley of Switzerland. As there was room only for one person, we took turns. Agassiz mounted first, resting on Jacob's arm. He remained about five minutes, and when he rejoined us, I saw he was unable to suppress the vivid emotion caused by the overwhelming grandeur of the spectacle."

"It is not the vast prospect that makes the charm of the higher mountains. We had already found, from former experience, that distant views are generally indistinct. Here, on the summit of the Jungfrau, the contours of the distant mountains were still less defined. But what fascinated us was the spectacle in our immediate neighbourhood. Before us was spread out the valley of Switzerland, and at our feet were piled up the lower chains, the apparent uniformity of whose height gave still greater sublimity to the vast peaks that towered up almost to our level. At the same time, the valleys of the Oberland, which, until now, had been covered by light vapour, were uncovered in several places, revealing to us, through the fissures, the world below! We distinguished, on the right, the valley of Grindelwald; on the left, far below, an immense chasm, at the bottom of which a brilliant thread wound along, following its windings. This was the valley of Lauterbrunnen, with the river Lutschiner. . . . On the south the view was interrupted by clouds, which had for some hours been gathering on the Monte Rosa. We were recompensed for this, however, by a very extraordinary phenomenon, which took place under our eyes, and interested us much. A thick mist gathered on our left towards the south-west; it ascended constantly from the Rott-thal, and began to extend to the northward. We already feared lest it should surround us a second time, when we found that it terminated abruptly at the distance of a few feet from us. Owing to this circumstance, we beheld before us a vertical wall of mist, the height of which we estimated to be at least from 12,000 to 15,000 feet, since it rose from the valley of Lauterbrunnen to a considerable distance above our

heads. As its temperature was below the freezing point, the little particles of vapour were transformed into crystals of ice, and reflected the sun's rays in all the colours of the rainbow; we seemed to be surrounded by a mist of gold."

The scientific results of this ascension were,—the discovery that the snow, even on the highest summits, is not changed into ice, though it rests on a crust of very compact ice; also, that the summit of the Jungfrau is gneiss, and not limestone, as had been supposed. Among the lichens gathered by M. Agassiz at the summit was a new species (*Umbilicaria virginis*, Schær.); the others were among those found by Saussure on Mont Blanc.

The general features of M. Agassiz' history since 1845, are probably known to most of our readers. In the autumn of 1846, being charged with a scientific exploration by the King of Prussia, and having also received an invitation to lecture by the Lowell Institute, he arrived in this country, where he has since resided. On the establishment of the Lawrence Scientific School at Cambridge, the professorship of zoology and geology was offered to him, and, after some deliberation, accepted. Of the results of his labours in this country it is yet too soon to speak; but the impulse given to these studies by his presence is a matter of public notoriety, and of the highest importance to scientific culture among us.—(*Massachusetts Quarterly Review*, Dec. 1847.)

The following Articles, written by Professor Agassiz, or prepared from his Works, have appeared in the Edinburgh New Philosophical Journal.

1. On a New Classification of Fishes, and on the Geological Distribution of Fossil Fishes; by Professor Agassiz; vol. xviii., p. 175. 2. Work of Agassiz on Fossil Fishes; vol. xix., p. 33. 3. Upon Glaciers, Moraines, and Erratic Blocks; by Professor Agassiz; vol. xxiv., p. 364. 4. Remarks on Glaciers; by Professor Agassiz; vol. xxvii., p. 388. 5. Remarks occasioned by Dr Mandl's Observations on the Structure of the Scales of Fishes; by Professor Agassiz; vol. xxviii., p. 287. 6. On Fossil Fishes found by Mr Gardner in the Province of Ceará, in the North of Brazil; by Professor Agassiz; vol. xxx., p. 82. 7. New Views regarding the Distribution of Fossils in Formations; by Professor Agassiz; vol. xxxii., p. 97. 8. A Period in the History of Our Planet; by Professor Agassiz; vol. xxxv., p. 1. 9. Report of the Researches of M.

Agassiz during his last two Sojourns at Le Hotel des Neuchâtelais, upon the Lower Glacier of the Aar, in the years 1841 and 1842; by M. E. Desor: vol. xxxv., p. 166—continued through several Numbers of this Journal. 10. On the Classification of Fishes; by Professor Agassiz; vol. xxxvii., p. 132. 11. On Fossil Fishes; by Professor Agassiz; vol. xxxvii., p. 331. 12. Remarks on Professor Pictet's Treatise on Palæontology; by Professor Agassiz; vol. xxxix., p. 295. 13. On Fossil Fishes, particularly those of the London Clay; by Professor Agassiz; vol. xxxix., p. 321. 14. Remarks on the Observations of M. Durocher, relative to the Erratic Phenomena of Scandinavia; by Professor Agassiz; vol. xl., p. 237. 15. On the Ichthyological Fossil Fauna of the Old Red Sandstone; vol. xli., p. 17.

Researches into the Effects of certain Physical and Chemical Agents on the Nervous System. By MARSHALL HALL, M.D., F.R.S., Foreign Associate of the Royal Academy of Medicine of Paris, &c. (With a Plate.) Communicated by the Author.

(Concluded from vol. xlv., p. 267.)

SECTION II. *On the Electrogenic Condition of the Spinal Marrow, and of the Incident Spinal Nerves.*

In the former section of this paper I gave an account of the electrogenic condition of the nervous system, in its simplest forms, viz., as induced in the muscular nerves; and I detailed the influence of moisture, which is analogous, I believe, to its simultaneous discharge; of dryness, which is equivalent to its interrupted discharge, together with its own peculiar effect; of restricted or extended points of Voltaic contact, and of various modes of connection of the wire proceeding from the voltaic apparatus, or of the nervous and muscular structures together, and with each other.

That paper may be regarded as strictly preliminary to the present one, in which I propose to treat of the electrogenic state in the spinal marrow and in incident nerves, and, more at length, of the collateral experiments to which I have alluded in the concluding part of the preceding paragraph.

I have hitherto avoided all speculations on the nature of the various phenomena or conditions induced. I would still carefully distinguish between any such speculations which the present paper may contain, and the phenomena or facts

which I may detail, and which I believe to have been most carefully as well as very repeatedly observed.

When a muscular nerve, and, as will be shortly stated, when the spinal marrow is made the conducting medium of the Voltaic influence, there is at the moment of completing the circuit, and once only, a degree of muscular contraction proportionate to the power of the agent and the susceptibility of the animal.

This phenomenon is repeated on breaking and re-completing the Voltaic circuit; and if this be done rapidly, as in the case in which the connections of the apparatus and of the nervous tissue is not uniform and continuous, repeated contractions are produced. On breaking the circuit, after its completion has been continuous during a certain space of time, a tetanoid state is observed,—the effect, as I have suggested, of a slow and interrupted discharge of the electrogenic condition of the nerve into the muscles. The precise direction and condition of this discharge in the muscle or muscles require investigation. It is especially a question, Whether a Voltaic circle be formed within these organs?

In addition to the electrogenic condition of the spinal marrow and of the incident nerves, the following circumstances will be submitted to the consideration of the Society in this paper, viz., that,

1. The electrogenic state of the nerves admits of being discharged, and is capable of inducing the phenomena of Voltaism in other nerves.

2. This state is inducible by momentary and slight Voltaic currents.

3. It is more inducible by the reverse than by the direct Voltaic current, as stated by Signor Matteucci and others.

4. When a nerve forms a part of the Voltaic circle, new and superadded circles may be effected, which, by inducing a *change* in the condition of the first, result in the phenomena of muscular contractions.

5. When the Voltaic circle is either complete, or, having been completed, is broken, and various parts of the wires and animal tissues, which form or formed that circle, are *connected* by a conductor, a series of phenomena is produced, *some of which* still require explanation.

6. It is also important, especially in a medical point of view, to observe the manner and degree in which the *vis nervosa* and the *vis muscularis* are diminished by repeated Voltaic action.

I. *On the Electrogenic Condition of the Spinal Marrow.*

We made many unsuccessful attempts to effect the electrogenic condition in the spinal marrow. If we passed the Voltaic current through this structure, still contained in the spinal canal, the conductivity of the surrounding tissues prevented the induction of the electrogenic condition in the spinal marrow itself, and the presence of a bony case, and the want of firm membranes, inclosing the spinal marrow, rendered it extremely difficult to denude and isolate this organ.

Ex. 1. Our first experiment is represented in fig. 1. of Plate I., the Voltaic current being made to pass in the direction of the arrows, from the spinal extremities of the brachial nerves to those of the lumbar nerves, these nerves themselves being excluded. In this manner, the spinal marrow was partially exposed to the Voltaic current. But we found it impossible to produce the phenomena of the electrogenic condition, whether we employed the direct Voltaic current, as represented in the plate, or the *inverse* current.

Ex. 2. Our next experiment is represented in fig. 2. The head being removed, the lowest part of the spinal column, technically the coccyx, was very carefully separated, and every particle of muscle, or other humid tissue, was carefully detached. We then inserted the end of one of the wires of the voltaic circle within the spinal canal at the upper, and the other at the lower orifice, thus effected, whilst we laid the spinal column itself over a piece of sealing-wax, so that it might become insulated, and its surface become dry.

We now succeeded in inducing the electrogenic condition of the spinal marrow; not, however, by the direct current, as represented in fig. 2, but by the inverse current applied by reversing the wires of the Voltaic circle.

The phenomena were the same, tetanoid contractions of the muscle of the lower limbs (with slighter movements of the anterior extremities), as are observed when the lumbar nerves were subjected to the same current.

Having failed in inducing the electrogenic condition by the direct current, the conduction of the surrounding part, after all our precautions, preventing the induction of the contained structure by this means, it was necessary to devise some new mode of experiment.

Ex. 3 and 4. Our first attempt was to denude and raise the spinal marrow, by removing the bony case at the posterior part of the canal; our second was to effect the same object by removing the bodies of the vertebræ at the anterior part of that canal. We succeeded eventually in both. But the latter result, on account of the less hardness of this part of the bony structure, is much more easily obtained than the former.

Having denuded the spinal marrow, we raised it from its bony case, with the utmost care, and gently placed it on the zinc portion of the Voltaic arc of silver and zinc, whilst the silver was placed on the lowest part of the spine, so that the Voltaic current was directed in the spinal marrow as represented in fig. 3. In four minutes, the spinal marrow being raised from its contact with the zinc, we had distinct tetanoid contractions of the femoral muscles, not to be distinguished from those produced by the electrogenic state of the lumbar nerves. This state ceased instantly on dividing the spinal marrow at its lowest part.

We learn from these facts, as from some of those which were given in my former paper,—

1. That the contiguity of humidity prevents the electrogenic induction of the nervous tissues; and, 2d, that the inverse voltaic current effects the electrogenic condition more readily than the direct.

I may here state that on one occasion I observed that the lumbar nerves became subject to the electrogenic condition, whilst still in contact with the lumbar tissues, as these became partially desiccated, an effect which ceased on the free application of moisture. And it was always observed, in the experiments in which the Voltaic current ascended one lumbar nerve and descended the other, that the ascending current first induced the electrogenic state.

Ex. 5. We removed the head and the bodies of the verte-

bræ in a frog, and then the lateral and posterior parts of the bony canal, so that the spinal marrow was denuded on all sides. We placed the upper part of this organ on a piece of platinum connected with the silver end of the "couronne de tasses," and placed the other wire under its lowest part, so that the direct current passed along it. Tetanoid contractions were observed on "breaking" the circuit in twenty minutes.

After discharging this condition of the spinal marrow, by connecting the wires after breaking the circuit, we could not succeed in reproducing the electrogenic state by the *direct* current. On reversing the current and breaking it after a time, movements were observed, but no tetanoid condition.

This phenomena was still more marked on connecting the wires, both before and after breaking the circuit, rather less in the latter case, and ceasing after several repetitions of the connections.

Ex. 6. We successfully divided and detached the spinal marrow, and laid it over the Voltaic arc, the upper extremity on the zinc, the lower in contact with the silver, so that the current through it was *direct*. In four minutes there was the most distinct tetanus *on breaking*, which ceased on remaking the circuit.

This was repeated in five minutes more.

We then reversed the order of the Voltaic arc and the current; the tetanus continued for several minutes, ceasing gradually.

Now, on breaking, the tetanus was renewed, but in a modified form, and it did not immediately cease on renewing the circuit, but subsided gradually.

A few minutes after the subsidence of the tetanus, fresh tetanoid spasm was induced on breaking the circuit, now instantly ceasing or remaking it.

On again reversing the current, energetic tetanus occurred on breaking the circuit after a time, which instantly ceased on dividing the spinal marrow at its lowest part.

Ex. 7. We removed the head, and having laid bare the spinal marrow, by removing the anterior bodies of the vertebrae, raising it from the spinal canal, placing it on the zinc part

of the arc of zinc and silver, the silver being under the lumbar tissues :

In four minutes we raised the spinal marrow from the zinc ; there was tetanus.

We again raised it in five minutes more, and then divided the spinal marrow close to its lower part ; the tetanus ceased instantly.

Ex. 8. If the frog be prepared as in fig. 2, and the Voltaic circuit be inverse or upward in the spinal marrow ; and if *a* and *c* be connected, there are movements in the corresponding extremities ; viz., *a* and *c* ; if *b* and *d* be connected there are movements in *b* and *d* ; and on breaking the circuit there is tetanoid spasm in the lower extremities *c* and *d*.

On reversing the Voltaic current and breaking the circuit, there was no tetanus.

On recompleting the circuit and connecting the Voltaic wires, there were strong movements in all the limbs. On breaking the circuit and connecting, there were still movements, but they were slight.

Ex. 9.—On repeating the experiments described in fig. 2, with the inverse current, there were movements in all the limbs on connecting *e* and *f* ; on connecting *e* or *f* and *a*, there were movements in *a* ; on connecting *e* or *f* and *b* in *b* ; *e* or *f* and *c* in *c* ; *e* or *f* and *d* in *d* ; on connecting *a* and *c*, *b* and *d*, *a* and *b*, and *c* and *d*, no effect was observed.

II. *On the Electrogenic State of Incident Nerves.*

The physiologist acquainted with the recent progress of our knowledge of the nervous system will readily imagine the importance of the next question to be submitted to the Society, viz., whether the incident spinal nerves, as well as the spinal centre itself and the muscular nerves, are susceptible of the electrogenic state, with its independent phenomena.

It was difficult to submit this question to the test of experiment. It was difficult to denude and isolate incident spinal nerves of adequate magnitude. At length it was found, that if a portion of integument over the dorsal region of the frog was detached by incision from the rest, and gently raised, several pairs of nerves were discoverable proceeding from the

inter-vertebral spaces to that integument which, the head being removed, could only act in their capacity of incident nerves of the spinal system. Unfortunately these nerves, the largest of the kind, were still of small dimensions; they are also speedily desiccated, if exposed so as to stretch in their denuded state through a portion of atmospheric air.

The results of our researches are given in the following detail of experiments:—

Ex. 10. We removed the head and then divided the integuments in two parallel lines, about half an inch asunder along the spine; the intervening portion of integuments being detached all round and raised, the cutaneous nerves are, as I have stated, seen passing to it in pairs proceeding from the spinal marrow.

If when thus detached, this integument is irritated by the forceps, the brain being removed, distinct reflex actions are observed; they are incident excito-motor nerves.

We now raised this portion of integument on the zinc portion of the Voltaic arc of zinc and silver, the silver being retained in contact with the lateral part of the animal; the current proceeding in the incident direction, therefore, through the nerves, no movements were observed on breaking the circuit.

Ex. 11. In another experiment we prepared the frog in the same manner, and placed the platinum wire from the silver end of the Voltaic "couronne de tasses" under the integuments, and the other underneath the abdomen, the current pursuing the same incident course as before; very slight movements were observed on completing the circuit, but none on breaking it, and no tetanoid phenomenon could be produced.

Ex. 12. We removed the head, and, by means of longitudinal and transverse incisions, raised the integuments still attached by their nerves, placing them over the wire proceeding from the zinc end of the battery of 50 plates, one inch square of copper and zinc, whilst the copper wire was placed in contact with the muscles of the dorsal region, the Voltaic influence pursuing, in the nerves, a direction *contrary* to the *incident*. On completing the circuit, slight movements of the

dorsal muscles were observed, on breaking it none. On connecting the wires of the completed circle, still greater movements of the dorsal muscles occurred, together with reflex movements of all four extremities.

Ex. 13. We prepared the frog in the same manner as before, and passed the current from the small battery in the contra-incident direction, through the dorsal incident nerves. After the lapse of five minutes, considerable muscular contraction was observed on breaking the circuit, and slighter on remaking it. When the circuit was broken, no effect was observable on connecting the wires; but on remaking the circuit and connecting the wires, there were energetic muscular movements of the body, and reflex movements of the lower extremities.

It may be a question whether there be, in the experiments already detailed, any evidence of an electrogenic state of the incident nerves. The difference of degree in the effect observed on completing the Voltaic circuit, and on connecting the wires whilst this circuit is perfect, can, however, scarcely be attributed to any other cause. It may not be in the nature of an incident influence to induce forcible tetanoid spasms. In the frog the incident nervous tissues are also on too small a scale for this purpose. Ordinary reflex actions were readily induced by irritating the integuments raised from the back, but still attached through the incident nerves; but nothing like the continued muscular action seen in the decapitated turtle, on pinching the extreme parts of the fin or extremities.

Ex. 14. The frog was prepared as before, and the current was passed along the incident nerves, in the contra or incident direction. There was, in the very first instance, considerable movement and reflex action on completing the circuit; still more, the current being complete, on connecting the wires of the Voltaic apparatus. These phenomena ceased in a very short space of time.

I was still anxious to obtain more unequivocal results in my attempts to induce the electrogenic state in *incident* nerves, those nerves which my former labours had first detected, and recommended to the attention of physiologists.

I, therefore, continued my experiments, and finally with complete success.

Ex. 13. We removed the head of a frog, and denuded the lumbar nerves.

We passed the direct current from one Voltaic arc of silver and zinc, through these nerves, for four minutes. On breaking the circle, there were movements of the anterior extremities.

We again made, and again interrupted, the Voltaic circle ; there were no movements of the anterior extremities. We now remade the circle, and continued its influence for several minutes ; on breaking it, there were again movements of the anterior extremities.

This proceeding was repeated again with the same results ; a momentary intermission of the circle was followed by no effect on the anterior extremities on breaking ; the continued Voltaic influence was followed, on breaking, by contraction of their muscles.

This phenomenon could only arise from the electrogenic state of the incident portion of these nerves.

Ex. 14. This experiment was repeated. On first making the direct current, as before, there were reflex movements of the anterior extremities.

On allowing the current to exert its influence during four minutes, and then breaking the circle, there were again movements of the anterior extremities. This was repeated.

On remaking and breaking the circle immediately, there were now no movements of the anterior extremities ; but, on continuing the influence of the Voltaic arc for several minutes, and then removing it, there were again movements of the anterior extremities,—the effect of the electrogenic state of the nerves.

Ex. 15. We repeated this experiment, applying the *inverse* current.

There were reflex movements of the anterior extremities on making the circle ; but none on its interruption, after an interval of four minutes.

It will be remembered that the *inverse* current is more apt to induce the phenomena of the electrogenic state than the

direct. Now, the inverse current in mixed nerves, is the direct in their incident portions.

Ex. 16. We prepared a frog, as before, and having divided the junction between the femora, we placed the feet on separate discs of silver, and passed through them the influence of three Voltaic glasses, so that the *direct* current passed along the nerves of the *left* extremity, and the *inverse* along those of the *right*.

On completing the circle, the anterior extremities were moved; on breaking it, after four minutes, the same phenomenon was observed.

This result was obtained several times.

The proof that the electrogenic state may exert its influence in an incident and retrograde direction in the nervous system, may, therefore, be considered as complete, whilst new light is thrown on that system of incident nerves which has now, for many years, occupied my continued attention.

III. *On Primary and Superadded Voltaic Circuits.*

I have incidentally described the principal phenomena of the primary voltaic current passed severally along the lumbar nerves, the spinal marrow, and the incident dorsal nerves. These phenomena consist in muscular contractions, which occur when the current is effected, and which, if this current be uninterrupted, cease immediately.

No author has noticed as they deserve, or as I believe at all, the extraordinary phenomena of Voltaic action in currents, superadded to the primary current. It is, therefore, to these I wish to call the attention of physiologists.

I will suppose the denuded and insulated lumbar nerves to be included in a Voltaic circuit, proceeding from the "couronne de tasses," or induced by the application of the Voltaic arc of zinc and silver. If now connections be made, so as to effect new or superadded circles, traceable through the zinc and silver, and the parts so brought into connection with them, muscular movements are produced, affecting parts not affected before, which are new.

That the new movements depend on new circles formed, is proved by their continuance after the tissues involved in

the first circles have been divided, and the primary circle of course interrupted. This fact may be illustrated by the following experiment.

Ex. 15. If the frog be prepared as in fig. 5, in every respect, muscular movements are observed in the lower extremity *c*, when the Voltaic arc is placed in contact with the nerve and muscle; but no movement is observed in *b*. If now the portion of platinum placed in accurate contact with the limbs *b* and *c*, be connected by means of a platinum wire, movements are observed in both the limbs *b* and *c*.

That these movements in *b*, depend on a new circle passing from the zinc to the silver through the spinal marrow, and the two limbs *b* and *c*, is proved by their persistence, after the removal of the primary circle by dividing the nerve at *e*.

It is not necessary that a perfect Voltaic arc be placed on the nerve and muscles. It may be, as represented in fig. 6. If a piece of zinc only be placed in contact with the nerve, as in this figure, and connection be made by means of a *platinum* wire between the plate of zinc and the plate of platinum *b* or *c*, movements are observed in the limbs *b* and *c*, respectively. The direction of the current is doubtless that portrayed by the arrows.

Sometimes, in addition to the movements of the limb *b*, when the zinc and this last are brought into connection by means of the platinum wire, movements are *also* observed in *c*, and *vice versa*. When *c* is brought into connection with the zinc, there are movements in *b*; these movements are doubtless *reflex*.

Movements are observed in both limbs, when the plate of zinc and the small plate of platinum placed over the spinal column at *a*, are brought into connection. No movements are observed at the first, when *b* and *c* are united.

It now remains for me to point out a new series of phenomena.

Ex. 16. In the first instance, no movements are observed in *b*, on making the connection between the portion of the platinum at *a* and at *b*, but when the plates of platinum at *a* and *b* have been connected with the portion of zinc, by

means of the platinum wire, movements are observed on connecting the plates *a* and *b*. The nerve *d* has become affected with the electrogenic state, and this is discharged with muscular phenomena, on uniting *a* and *b*.

Ex. 17. Our next experiment is portrayed in fig. 7. The plates of platinum connected with the "couronne de tasses" are laid across the lumbar nerve at *d* and *e*, the direct current passing through the intervening portion of nerve.

On completing the circle, muscular movements were observed in the right posterior extremity *b*. On connecting *a* and *b*, there were slight movements in *b*, but none in *c*. On connecting *a* and *c*, no movements occurred either in *b* or *c*. On connecting *b* and *c*, energetic movements were excited in both these limbs. On connecting *d* and *f*, *e* and *f*, and *d* and *e*, movements occurred in *b*. After these experiments, on connecting *d* and *a*, there were movements in both limbs, the induced nerve and the spinal marrow being a part of the circuit. On connecting *a* and *b*, there were movements in *b*, and reflex movements in *c*.

If the Voltaic circle now be broken,—if the whole Voltaic arrangement be removed, a series of phenomena are still observed; thus,—if under these circumstances we unite *d* and *c*, and *e* and *c*, there are movements in the limbs *b* and *c*; if we connect *d* and *b*, and *e* and *b*, there are still movements in *b*, greater in the former case, less in the latter; the right lumbar nerve being and remaining in the electrogenic condition, and being then discharged with muscular movements.

Ex. 18. If the experiment be arranged as in fig. 8, there are movements on connecting *c* and *a*, *c* and *b*, and *c* and *d*; but none on connecting *a* and *b*, *b* and *d*, and *d* and *a*.

It will be observed, that movements take place whenever the connections are so made as to admit of new or superadded circles, including the zinc and silver arc, but not otherwise; that is, in the first instance; for one such connection with its attendant movements is sufficient to effect an electrogenic state of the nerve, the action of which may be independent, and persist after the Voltaic apparatus is removed.

Ex. 19. This experiment is represented in fig. 9; the current from the "couronne de tasses" is direct in the limbs *a*

and *c*, and inverse in *b* and *d*. After ten minutes of continuous current, all the limbs were affected with tetanoid spasm on breaking the circuit. After the lapse of a longer time, the current being removed and uninterrupted, the tetanoid spasm ceased first on breaking the circuit in the limbs *a* and *c*, remaining in *b* and *d*; on remaking, a single movement was observed in *a* and *c*, while *b* and *d* became simply flaccid. Such is the difference in the effect, arising from the direct and inverse currents.

On laying the galvanoscopic frog across from *c* to *d*, before and after breaking the circuit, movements were observed in the limb, the nerve being exposed in the former case to the direct, in the latter probably to the inverse current, as denoted by the arrows.

I have now to add, that whatever the effect observed on making or breaking the circuit, including the lumbar nerves, may be, a far greater effect is observed on completing the circuit, and connecting the wires of the Voltaic apparatus. This is especially observed in all cases in which the powers are beginning to be exhausted.

The experiment implies probably not merely the subtraction of the primary Voltaic current, but the institution of a reverse current, and the degree of effect is probably commensurate with the *difference* of the two conditions. To this must be added the effect of the discharge of the electrogenic condition.

This last is seen in its insulated form, on breaking the Voltaic circuit, and then connecting the wires. It is usually slight, and admits only of being repeated once or twice, each successive connection of the wires producing less effect than the preceding one, consisting in effect, of the discharge of the residual electrogenic condition.

In the former case, the movements are also more rapid, as well as more energetic, in the latter they are slower, and somewhat more continuous.

In conclusion I may observe, that I have purposely and carefully avoided all theoretical views, confining myself to the accurate detail of experiments. The condition induced in the nervous system, by a current of Voltaism, I have de-

nominated electrogenic. It might be viewed as one of polarization; its discharge one of depolarization. But I have nothing to add to these views, beyond what is universally known. The phenomena of the continuous, interrupted, and sudden discharge of the electrogenic condition, have not, I believe, been traced and detailed before.

On the Vegetable Colonisation of the British Islands, Shetland, Feroe, and Iceland. By M. CH. MARTINS.

Whether each plant has originated in the place where it is now found, or whether there be centres of creation, from which vegetables have been diffused by radiating over the surface of the earth, are the two systems which have long divided natural philosophers. Some of them, avoiding in some degree the discussion of the problem, suppose that the plant was produced in the locality where we now observe it vegetating; others, on the contrary, admit of great vegetable migrations similar to those of the human races. Applying to these questions the notions which geology furnishes respecting the past state of the globe, and such as are afforded by the physical history and meteorology of its present condition, they are not satisfied by regarding the geographical distribution of species as a fact without premises and without consequences. They endeavour to recognise in it the traces of the last revolutions of our planet, and the action of the numerous and varied forces which impede or favour the dissemination of vegetables in the present day. They attempt to trace on the map the progress of these vegetable armies which have invaded certain countries, while others have preserved their primitive flora. These studies are but of yesterday's date; but by submitting them to reflecting minds, we hope to make their importance felt. In fact, the creation of existing vegetables followed very closely upon the emergence of continents and islands. It is in some degree the last act in the geological history of our globe. Man appeared at a later period, and tradition commenced.

Botanists had long remarked that certain islands possess a flora which is peculiar to them, while others present no plant which is not found on the nearest continent. Such is the case with the British Islands; but we shall not confine ourselves to the study of the vegetation of England, Scotland, and Ireland, but endeavour to follow the vegetable migrations in that series of archipelagoes, islands, and islets, which, under the name of Orkneys, Shetland, Feroe, and Iceland, form the only chain which unites middle Europe to North America.

Let us first attend to the botanical geography of the British Islands. In this study we have for our guides the beautiful works of Mr Hewett Watson* and Mr Edward Forbes.† Both have carefully examined their country; the one as a botanist, the other as a zoologist and geologist. An important and capital fact gives all the results to which these naturalists have arrived, namely, that the British Islands do not furnish a single plant which is not found on Continental Europe.‡ These islands cannot, therefore, be considered as a centre of vegetation, since all the plants which inhabit them likewise exist on the European Continent. But all do not come from the same regions of Europe, and we shall recognise, along with Messrs Watson and Forbes, a series of vegetable migrations which have successively colonised the British Islands.

1. *Asturian Type*.—Owing to the mildness of its winters, Ireland has preserved for us, so to speak, the remains of a peninsular flora. In the south-west of that island, we find in a wild state, twelve plants, original natives of the Asturias, which have maintained themselves in Ireland as the last

* Remarks on the Geographical Distribution of British Plants, chiefly in connection with Latitude, Elevation, and Climate. One vol. 8vo, 1835; and *Cybele Britannica*, vol. i., 1847.

† On the Connection between the Distribution of the Existing Fauna and Flora of the British Isles, and the Geological Changes which have affected their Area, especially during the epoch of the Northern Drift. (*Memoirs of the Geological Survey of Great Britain*, vol. i., p. 336, 1846.)

‡ A single species only, *Eriocaulon septangulare*, cast on the shores of the Hebrides, is a native of North America.

relics of a colony whose point of departure was the north of Spain. Confined to the western coast, these plants do not exist in the eastern provinces of the island. We shall afterwards endeavour, with Mr Forbes, to discover the probable causes of this migration, the most ancient of all, since it supposes a temperature and a distribution of lands and seas very different from what they now are.

2. *Armorican Type*.—The south-west of England and south-east of Ireland, present us with a vegetation whose analogy with that of Brittany and Normandy has long struck botanists. Many southern species are met with along the western coasts of France, until the always increasing rigour of the climate arrests them in their migration towards the north. A certain number of these plants still find in the peninsula whose extremity is occupied by Cherbourg, a temperature so mild in winter that they maintain their position there notwithstanding the lateness of the summers. These plants are then spread over the south-west of England, along the coasts of Devonshire and Cornwall, whence they have reached the opposite shores of Ireland, and have become naturalised in the counties of Cork and Waterford. It was in this manner that the Normans formerly left these same shores under the guidance of William the Conqueror, in order to invade England. But the vegetable occupation has not passed beyond the south of the island; and the severity of the climate, which presented no obstacle to man, formed an insuperable barrier to the invasion of vegetables.

2. *Boreal Type*.—The mountains of Scotland, Cumberland, and Wales, present a special vegetation to the botanist, different in every respect from that of the plains of England. Analogous to that of the Alps of Switzerland, this flora has a still more striking resemblance to that of the arctic countries, such as Lapland, Iceland, and Greenland. The greater number of plants which live on the summits of the high mountains of Scotland, grow at the level of the sea in the islands of the Icy Sea; but there are many of them which have not been observed among the Alps of Switzerland. At the same time the immense majority of these vegetables exist at

once on the coasts of the polar lands and on the snow-crowned summits of the Alps of central Europe.

4. *Germanic Type*.—It is this which predominates in England, and forms, so to speak, the very basis of the vegetation. Originating from the north of France and Germany, these plants have occupied the greatest part of England, Scotland, and Ireland, as formerly the Saxons invaded the country of the Angles in order to substitute themselves in their room. If it be true that the aboriginal masters of the country disappeared after the invasion, it is, perhaps, also the case that the plants of Germany extinguished those which formed the primitive vegetation of these islands. With the lapse of time the Germanic type has become so predominant, that the greater part of English botanists designate it by the name of the British type. But a certain number of plants belonging to this type have not crossed the strait which separates England from Ireland, while the rest of the migration surmounted this obstacle. Those species, common on the English coast bordering St George's Channel, are unknown on the opposite coast of Ireland.

The studies of the zoologist tend to confirm, in every point, the inductions drawn from botany. Certain animals widely spread in Germany are restricted in England to regions where the Germanic flora exclusively prevails; thus the common hare, the squirrel, the dormouse, and mole, are confined to England, and do not occur in Ireland. Five species only represent the class of reptiles in that island. Eleven of them exist in England and twenty-two in Belgium, the point whence the Germanic migration took its departure. The living molluscs, such as the different species of *Helix* and *Clausilia*, are distributed in the same manner.

The maritime fauna and flora obey all the laws which regulate the distribution of vegetables and land animals. Certain genera of marine Algæ, proper to the southern counties, are found only on the western coasts of England; and we there find species of fishes which never go beyond the Straits of Dover or St George's Channel. These are the Neptunian representatives of the Asturian and Armorican types. In like manner the herring, cod, and coalfish, abound only in the

North Sea, and along the eastern coasts, where the Germanic type predominates. Finally, the large Cetaceæ, such as the whales, narwals, and dolphins of the arctic seas, seem to respect, even in the bosom of the ocean, the ideal limit which separates the northern vegetation of Scotland and England from the more southern floras of Cornwall and the South of Ireland.

Hitherto naturalists have seen nothing more in this distribution of living beings, according to certain determinate regions, than a natural consequence of the all-powerful influences of climate and soil. If some plants of the Asturias maintain themselves in the south of Ireland, it is owing, they alleged, to the circumstance of their finding there the temperate winters of the Iberian peninsula, and the summers of Ireland, though without great heat, were sufficient to ripen their seeds. In like manner, the plants of Bretagne and Normandy have been able to pass the strait and occupy Cornwall and Devonshire, where a climate prevails analogous to that of their native country. The hardy vegetables of Germany have found, in the middle regions of England, in the south of Scotland and north of Ireland, conditions of existence analogous to those of the north of Germany and France; hence their multiplication and diffusion in the greater part of the British Islands. Finally, the rocks, turfy slopes, peat-bogs, and marshes of Scotland, offered varied stations, cool summers, the long sleep of winter, and the protecting snows of the polar lands, to the arctic plants.

Mr Edward Forbes is not contented with these explanations; he has found a deeper sense for the existence of these foreign types which constitute the fauna and flora of the British Islands. He imagines that he finds in it the vestiges of an order of things which no longer exists,—proofs of the existence of warmer or colder climates than the present,—the indications of a configuration of the lands and seas, the marks of which are concealed from our view by the depths of the ocean. Let us follow him in his ingenious and skilful researches. Penetrating for the first time into a new field, he may often have mistaken the path. But he connects, with a powerful hand, the past history of our globe with the present;

he brings all the kingdoms of nature to bear testimony to his idea ; and, even though he may be mistaken, he has not on that account contributed less to the progress of the natural sciences by completing the overthrow of the imaginary barrier which learned men and tradition have raised between the actual condition and the geological epochs of our planet.

The twelve plants originating from the Asturias which inhabit the south-west of Ireland, Mr Forbes regards as the remains of the most ancient vegetable colony of the British Islands. Of all the plants now living there, there are none more foreign to the soil which supports them. The distance of their point of departure on the continent,—the vast gulf which now separates this small colony from the mother country,—the difference of climates,—the small number of surviving species,—every thing, announces an ancient origin and an order of things completely different from that which now prevails. In order to determine it, Mr Forbes goes back in the series of geological formations, and transports us to an epoch when the last tertiary formations were deposited in the bottom of a sea which covered a great part of the south of Europe and north of Africa. The existence of this sea is proved by the numerous identical fossil shells, which we find at a multitude of points, from the islands of Greece to the south of France. When these newly-formed lands rose above the sea, they formed a vast continent, comprehending Spain and Ireland, a part of the north of Africa, the Azores, and Canary Islands.

The upheaval from the bottom of this sea is not a gratuitous hypothesis, since Mr Forbes has found these same shells in the Taurus, to the height of above 1800 metres above the level of the Mediterranean. But more than this : the great bank of floating algæ which extends in a semicircle beyond the Azores, from the 15th to the 45th degree of latitude, perhaps marks out the contours of this lost continent. Its shores have disappeared under the sea, but the girdle of marine algæ which surrounded it, still floats on the surface of the waters.*

* This bank is formed of a species of Alga, the *Sargassum bacciferum*, which

According to Mr Forbes, the appearance of Armorican plants in Devonshire, Cornwall, and the south-east of Ireland, is connected with the existence of this destroyed continent. The southern physiognomy of these vegetables is, in his view, the indication of a more temperate climate than the present. At the same time, there is nothing to prevent us regarding this migration as contemporaneous with the Germanic invasion, referring it to the epoch when England and France were still united.

The immersion of this great continent was followed by a period completely different, during which the temperature of the air was lower than it now is. It was during this period, according to Mr Forbes, that the migration of the arctic plants which have maintained their position in the mountains of England and Scotland, took place. The proofs of a glacial period immediately preceding that in which we live, abound throughout the whole north of Europe.

I shall not speak, in this place, of the numerous traces of ancient glaciers found in the mountains of Scotland, England, and Ireland, but confine myself to the arguments derived from the animal kingdom.*

The greater part of the British Islands is covered with a moveable formation composed of transported materials, which English geologists call drift. In the northern two-thirds of England and Ireland, and in all Scotland, this drift contains the remains of animals no longer found in a living state, except in the bosom of the Icy Sea, on the coasts of Iceland and Greenland. The enumeration of these would be tedious. I shall merely mention the *Balæna mysticetus*, the large-headed cachalot, a baleinopteron, the narwhal, a cetacea of the Greenland seas, and a great number of shells, which still exist in the same latitudes. During this period, England was, therefore, partly covered by waters whose temperature approached to that of the Icy Sea. Not only the plains, but also all the lower parts of the mountains, formed the bottom

appears to be only a floating variety of *Sargassum vulgare*, which is found fixed to the submarine rocks which border the coasts of Europe.

* See on this subject, Researches on the Glaciary Period and Ancient Extension of the Glaciers of Mont Blanc, from the Alps to the Jura, *Reveu des Deux Mon des*, vol. xvii., p. 919, 1st March 1847.

or shore of this ocean ; for beds of gravel, sand, and shells have been found in Wales, at a height of about 450 metres above the level of the present sea. At this period, England and Scotland did not form a continuous land, but a group of islands and islets. The mountains of Scotland, Cumberland, and Wales, alone rose above the waves. A climate analogous to that of Iceland reigned over this archipelago ; the summits of the mountains were covered with eternal snow like that of Hecla, and numerous glaciers descended the valleys to the edge of the sea. The plants of Greenland, Iceland, and Norway, carried by the currents, or transported by the floating ice, were thrown upon these islands, where they found a climate scarcely different from that of their native land. This transportation of plants by floating ice, is not a gratuitous hypothesis. The navigators of the Polar Seas have often met with icebergs, bearing an enormous mass of debris mingled with earth and gravel. Plants grow on these debris as among the median moraines of the glaciers of the Alps ; and the iceberg grounding on some distant shore, there deposits, so to speak, the plants, which afterwards spread over the country.

These arctic plants, says Mr Forbes, have not disappeared from England. They still exist among the mountains of Cumberland, in Wales, and especially in Scotland, where they find a climate analogous to that of their native country.

At the end of the glacial period, the British Islands began to rise slowly from the bosom of the waves. We still find, everywhere along the coasts, terraces or lines of ancient beaches, indications of the periods of repose which interrupted this gradual elevation. In order to understand this phenomenon aright, we must imagine not a simple elevation of the coasts, the submarine parts remaining immoveable, but the simultaneous rising of the bottom of the sea and the lands together, above their ancient level. It is this upheaving which has modelled the present relief of the British Islands, and determined the configuration and depth of the surrounding seas. The depressions have been rendered less deep, and the high bottoms have been brought above the waters. Hence, a change in the maritime fauna. The sea being warmer, its *coasts* were occupied by the animals which now

inhabit them. But the change of temperature being much less sensible at great depths, the animals of the glacial era have been able to maintain themselves there. Thus, according to Mr Forbes, in depressions where the soundings were from 160 to 200 metres, the drag brought up molluscs of the arctic seas, and even a great number of shells which exist in a fossil state in the drift or formation of the glacial epoch which covers the northern part of the British Islands. From this assemblage of facts, Mr Forbes concludes that the deep portions of the British seas conceal populations whose existence goes back to the glacial epoch like the appearance of the plants which crown the summits of the Scottish alps.

Throughout the whole duration of the two geological epochs we have been considering, England was united to France. The English Channel and Dover Straits did not exist. This is one of the facts of science, and all geologists are agreed in considering the separation of England from the Continent as an event comparatively very modern, perhaps even contemporary with man. MM. Constant Prevost and Archiac have perfectly demonstrated this. The former by pointing out the agreement which exists between the bed of chalk on the two sides of the channel; the second by proving the identity of the mass of rolled pebbles which covers the chalk. These masses, similar to those of our present rivers and water-courses, form the most superficial layer of the ground, that one, consequently, which is deposited after all the rest; since it is identical on the two sides of the channel, this layer has been deposited by the same current at the epoch when the two countries were united. The separation took place afterwards; it is owing to the rising upwards of the layers of chalk, which dip from the two sides towards the interior of the land, and appear elevated from the sides of the sea.

At the dawn of the present period, England, therefore, formed a peninsula similar to that of Denmark. The climate, the surface of the ground, were what they now are; and the plants of France and Germany soon invaded these recently-emerged lands. The hardy vegetables of the north of Europe occupied the greater part of the British Islands. Forests as gloomy as those of Germany then covered the hills of England. Marshy waters slept in the hollows; we still find, in

the peat-bogs which now occupy their place, the bones and antlers of gigantic stags, and the remains of the trees of these extinct forests. Lost species of the ox, bear, wolf, and fox, were the only inhabitants of these solitudes. The task of nature was completed; that of man began as soon as he appeared. The forests fell under his axe, stagnant waters were drained, cultivation extended, animals continued to disappear, the population increased, and the transformation of the ground was accomplished by the uninterrupted progress of civilisation. As the work of human power, this transformation is as complete, as profound, as that which took place in geological times, when the present epoch succeeded the glacial period.

If we endeavour to give a brief view of Messrs Watson and Forbes' notions respecting the origin of the flora and fauna of the British Archipelago, we should say, with them, that these islands have been peopled by many colonies successively leaving the Continent of Europe, from the epoch of the middle tertiary formations up to our own. When a vast continent extended from the Mediterranean regions to the British islands, the plants of the Asturias, and those of Armorica, peopled the south of England and Ireland. To this period succeeded the glacial epoch, during which the lands were immersed to a depth of about 450 metres. This is the period of the migration of the arctic plants which still inhabit the tops of the Scottish mountains. When these lands emerged anew, England was united to France, the temperature being such as it is at present. At this time the great German invasion took place, absorbed, so to speak, all the rest, and left very feeble remains of them. Thus, while the Asturian plants, those of the south, are reduced to a small number of species confined to the south-west of Ireland, the hardy vegetables of the north completed their conquest, and took possession of the ground which was to be occupied at a later period by a warrior race issuing from the same regions. The colonisation being completed, England became separated from the Continent; and this last geological event, so insignificant compared with those which preceded it, has exercised an immense influence on the destinies of the world. Less in-

sulated, England would have been less personal, and its energetic races might perhaps have been confounded with one of the great continental nations which peopled it.

While Messrs Watson and Forbes proved the continental origin of the plants and animals of England, I studied the vegetable colonisation of Shetland, the Feroe Islands, and Iceland. These islands form, as it were, a continuous chain, which joins the northern extremity of Scotland to the eastern side of Greenland. These are the only lands which unite Europe to America. I visited the Feroe Islands in 1839; the vegetation of this archipelago struck me. Although lost in the midst of the North Sea, its flora is composed of very common plants, the greater part of them indigenous to the plains of middle Europe, others to the Alps of Switzerland, some to Scotland and Greenland. Extending my investigations to Shetland and Iceland, I found, in like manner, that these islands have no vegetation peculiar to themselves, but that all their plants come from the mainland. This is the result to which Mr Watson came in his researches into the British Flora. But here a new problem presented itself; do these vegetable colonies come from Europe or America? A great number of plants being common to the northern parts of the Old and New World, the question presented some difficulties. I found more than a hundred species, *exclusively* European, among the plants scattered over the islands which I compared with each other; all the rest were common to Europe and America. Europe has therefore had the principal part in the colonisation of these archipelagoes; a great vegetable migration has advanced across England, Scotland, the Orkneys, Shetland, and the Feroe Islands, as far as Iceland. Some species have come directly from the coasts of Norway. But, at the same time, the arctic plants originating from Greenland followed an opposite progress, and propagated themselves across Iceland, Feroe, and Shetland, as far as the mountains of Scotland, where they found a second country. This double migration manifests itself by the numbers. If we calculate the relative proportion of the plants, *exclusively* European, which enter into the flora of Shetland, we find that it is a fourth, in that of Feroe it is not

more than a seventh, and, finally, a tenth in Iceland. In proportion, then, as we remove to a distance from Europe, the number of vegetables peculiar to that continent diminishes; but, at the same time, the proportion of the Greenland plants increases very nearly in the same ratio.

Completely agreeing with Mr Forbes as to the colonisation of the Islands of the North Sea, I yet demur at the boldness and novelty of the hypothesis he has advanced. Without interrogating the past history of the earth, I find in the action of existing causes a plausible explanation of the transport of the seeds of our continent to the nearest islands, and from one islet to another, from England as far as Iceland.

A great current, the Gulf Stream, has its source in the Gulf of Mexico, runs along the shores of North America as high as Newfoundland, then, traversing the Atlantic, washes the western coasts of Scotland. It is this which conveys to these coasts the seeds of Mexico, still endowed with the power of germination—it is this which has thrown on the shores of the Hebrides the *Eriocaulon septangulare*, a species belonging to North America, the only one of all the British plants which is not European. Running along the coasts of Scotland, the Gulf Stream collects, so to speak, the innumerable seeds which running waters convey to the sea, and carries them along with it to sow them on the sandy shores of Shetland, Feroe, and Iceland. This current appears to me to be the principal agent in the diffusion of European plants in these islands; and I do not hesitate to ascribe to them the predominance of the flora of Europe over that of North America.

Winds, true aerial currents, likewise perform their part in the dissemination of species, but like that of marine currents, it escapes direct observation. Whoever has once encountered the long-continued and terrible winds of the north seas, will no longer doubt that they are capable of transporting, from one island to another, light seeds, often provided with tufts of feathers and membranes which facilitate their suspension in the air. A recent fact adds new strength to this probability. On the 2d September 1845, at 9 o'clock in the morning, there was an eruption of Mount Hecla, in Iceland. On the 3d, the ashes fell on the most southern islands

of the Feroe group; on the same day they were carried to Shetlands, the Orkneys, and collected from the decks of vessels sailing between England and Ireland.

There is still another mode of transportation peculiar to the countries we are considering, and which does not appear to have been hitherto taken into account; I mean migratory birds. Every spring, millions of sea-birds leave the coasts of Spain, France, and England, and migrate to the north, in order to lay and hatch their eggs in the steep and deserted shores of Shetland, Feroe, and Iceland: the following autumn they return to Europe with their brood. These birds transport rapidly from one island to another the seeds of vegetables preserved in their gizzards, or attached to their feathers. They thus become the principal agent of the American migration, for it is exactly towards the end of the summer of these regions, at the time when seeds are ripe, that they return towards the south. In this journey, the islands of which we have been speaking serve them as a kind of provisional magazines or resting-points, and they sow there the seeds they have transported through the air.

When we reflect that all these causes united have acted incessantly since the beginning of the present epoch, that is to say, for thousands of years, we cannot question the principal effects of an action so prolonged. Accordingly, before going back in the series of geological ages to explain the distribution of organised beings on the surface of the globe, we must demonstrate the insufficiency of existing causes. This plan is applicable to all the problems of geology. Formerly, in the theological period of this science, the most extravagant imaginations were boldly indulged. According to the necessities of the case, sudden revolutions were supposed, or prodigious overthrows, colossal forces, unknown agents, and imaginary causes. Now, reflecting minds first seek the reason of geological facts in natural forces, acting within the limits of the power which they develop to our own view, and do not enter the field of conjecture till they have exhausted that of reality.—*Bib. Universelle, June 1848.**

* After the above was in types, we received, but too late for insertion, from M. Martins, a more detailed memoir on vegetable colonisation.—EDIT.

Anniversary Address, for 1848, to the Ethnological Society of London, on the recent Progress of Ethnology. By the President, JAMES COWLES PRICHARD, M.D., F.R.S. Corresponding Member of the Institute of France. (Communicated by the Society.)

(Concluded from vol. xlv., page 346.)

The contributions to history and ethnology which may be expected from Palæography, are but limited, since the art of writing was known only to a few of the nations of antiquity. The data which it furnishes have indeed the appearance of greater authenticity than those derived from the examination of languages, but this is principally because they are founded on phenomena which present themselves to the eye, while the testimony of unwritten speech is only heard. This last resource, however, is not only of far greater extent, but is capable of affording results equally deserving of reliance. The visible signs preserved in written memorials, must be translated into sounds before they can give testimony in questions relating to the history of races, and when oral speech is faithfully represented, and due care is taken to distinguish between what is accidental or acquired, and what is essential and original, it furnishes evidence not less credible than that of inscribed monuments.

In returning to this part of my subject, I may observe that every year brings out some new information derived from *Palælexical* researches, and that new associations are continually formed in Europe, Asia, and America, in which they are the principal objects of attention. The academies of St Petersburg and Berlin are now of old renown, and the Society of Northern Antiquaries has already subsisted for several years. The "Deutsche Morgenländische Gesellschaft" is of recent date, and the establishment of this association may be hailed as an event of great promise, since it promotes an union of the literary labours of all those learned men in Germany, who are engaged in the study of Eastern languages.

Some of the early papers of this Society contain a contri-

bution by a learned Finn, M. Kellgren, who has also published separately a very accurate and interesting work, on the class of languages to which his own national speech belongs, I mean the Ugro-Tartarian languages. Adopting the notion of Julius Klaproth, as to the origination of the tribes composing this family, from two chains of mountains, M. Kellgren terms the whole groupe, the "Ural-Altäisch Spradchstamm." We had some few years ago, a publication on the Finnish language and literature, by Dr Sjögren, of the university of Abo. But this paper, the work of a very distinguished philologist, though the title promised more, contained very little new information, either on the language of the Finns, or the compositions that are extant in it. On the mythological poems of the ancient Finns, the songs of their "*Runonieckas*," or bards, and the worship of their divinities, Ilmarinen, and Väinämöinen, much curious information was collected by Porthan, president of a literary society at Abo, and by Lencquist and Gannander, in the early part of the last century, and the subject has been well treated in a work published a few years since in Swedish, by M. Rühls, of which we have a translation into the German language. A remarkable trait, pointed out by M. Rühls in the poetical compositions of the ancient Finns, is worth noting, as it suggests an inquiry of ethnological import. In these verses the same principle of composition prevails which has been well known since the time of Bishop Lowth, as the leading characteristic of Hebrew poetry. The second verse in each distich or poetical sentence expresses in a more rhetorical or poetical style, or in a manner somewhat modified, the sentiment which was more simply uttered in the first.* This is so remarkable a trait of re-

* In a poem to Tapio, the god of the woods, an invocation occurs which exemplifies this style of composition.

O, thou Bee, smallest of birds,
Bring me honey from the house of the woods,
Sweet juice from the hall of Tapio.

The following invocation occurs in a hymn to the Finnish goddess of "Disease," who was styled the "*Daughter of Death*." It is translated by Lencquist.

semblance as to suggest a suspicion that it may be the result of later culture among the Finns, and, subsequent to their conversion to Christianity, or the introduction of the Hebrew Scriptures among them. But it appears to be a relic of antiquity, and is traced in their ancient pagan *Runot* or sacred hymns, addressed to the imaginary personages of their curious and not unpoetical mythology. The observation is the more interesting, as many writers have thought they observed analogy in numerous words of the Finnish dialects to the vocabulary of the Semitic languages. But the Finnish language belongs, in the leading features of its grammatical structure, and in a considerable proportion of its primitive words or roots, to the Ugro-Tartar, or, as M. Kellgren terms it, the Ural-Altaish family of languages.* The essential or deeply-rooted affinities of the various languages belonging to this groupe, have been illustrated with great ability and accuracy of information by this writer. The principal languages which he has compared with the Finnish speech, and which he considers as *sister languages*, are the Ougourian or Eastern Turkish, the Mongolian, the Tungusian or Mantchu-Tartar, and, lastly, the Hungarian or Magyar. For the future no reasonable doubt can be entertained as to the affinity of these languages and of the races of people to whom they respectively belong; and this must be considered as one of the last great facts in Ethnology, established by linguistical research, since it was unknown even to Klaproth and Abel Remusat. It has been a fortunate event for the progress of literary and ethnological researches connected with

" Morbus Puella, Mortis virgo (sc. filia)
 Morbos captivos factos includito
 In variegatum vas,
 In splendidam capsam."

* M. Kellgren has not given any new information as to the Lapponic. The affinity of this language to the Ugrian dialects was demonstrated by Gyarmathi and Vater. Some curious remarks on it may be seen in Dr M. A. Castren's late memoir, entitled, " Von dem Einflüsse des Accents in der Lappländischen Sprache." This paper was published in one of the last volumes of the "*Memoires présentés à l'Académie Impériale des Sciences à St Petersburg.* Tom. vi. 1846."

these nations, as well as for the social improvement and the tranquillity of the civilised world, that the sway of the great Northern Autocrat has been so long maintained over nearly the whole aggregate of nations belonging to the Ugro-Tartarian family, as well as over so great a portion of the Slavonian race. To the patronage of science, for which the Imperial Government of Russia has always been remarkable, must be attributed the progress already made in exploring the literature of nations, which, until lately, were scarcely known in Europe to possess any thing deserving that name. For example, the literature of the Mongolians, although their language had been cultivated, and they possessed a peculiar alphabet, since the time of Kubilai, the grandson of Tchinghis, was a complete blank, as far as Europeans were concerned, till M. Schmidt of Moscow translated the historical work of the Mongolian Khan Ssanang Setzen, of which M. Abel Remusat thought it worth while to publish an analysis. More recently, we have the commentaries of M. Gabelentz on the literature of the Mantchu-Tartars. The latest contribution to our knowledge of these nations and their literary culture, is a memoir in the last volume of the Berlin *Abhandlungen*, entitled, "*Ælteste Nachrichten von Mongolen und Tartaren*," by Professor Schott, already celebrated for his ingenious and most valuable researches into the structure of this family of languages.

The ethnology of the Caucasian nations (meaning the tribes of people who inhabit the chain of Caucasus and the adjoining lowlands, and not the European nations in general, commonly, but with very questionable propriety, so termed), has been a subject of research among German philologists, and several memoirs have lately appeared on the languages of these nations. The last volume of the Berlin *Transactions* contains several papers on the same subject. Among them is a memoir by Herr G. Rosen, "*über die Ossetische Spraché*." The Ossetes are well known to be a branch of the Indo-European stem, insulated among the Allophylian tribes of the Caucasus. This was discovered, as I believe, by *Klaproth*, whose information respecting the Ossetes was *otherwise* very defective and erroneous. This people call

themselves Irôn, and their country Iri, which names are thought to connect them with the Aridi or ancient Medes, and with the Aryas, or the higher classes of the Hindoos.* There is another memoir by the same author on the Mingreliin, Soaneân, and Abschassian languages, spoken by other nations of Caucasus, the tendency of which is to point out certain common characters in all these idioms, though they are still regarded as radically distinct. I must not omit to notice a memoir on a remarkable Caucasian tribe, the Kubetschi, by the learned Petropolitan academician, M. C. W. Fraehn, which appeared in the fourth volume of the *Bulletin Scientifique de l'Académie Impériale de St Petersburg*,† or to mention that the same volume contains an inquiry into the history of the powerful Afghan tribe of the Jusufzte, by B. Dorn,‡ who endeavours to follow up the investigations of our illustrious countryman the Honourable Mountstuart Elphinstone. With regard to the history of the Caucasian nations it may be remarked, that the whole subject requires further elucidation before we can venture to draw any general conclusions as to the origin of these tribes, and their relation to the great races of Europe and Asia; and I believe that this remark coincides with the opinion of Dr Latham, to whom we have been indebted for a learned memoir on the inhabitants of the Caucasian chain, read during the last winter before the Ethnological Society.

Considerable additions have been made during late years, and even during the last year, to our previous knowledge of the native races of India. In saying this, I need only to advert to the admirable series of papers read in this Society, by General Briggs, on the aboriginal tribes of the Dekhan, of which the learned author seems to know every corner and mountain range, with its inhabitants, with an accuracy and precision altogether unexampled. How ignorant we were only a few years ago of the real facts of Indian Ethnology,

* Is the name of Evl or Ive-land of the same origin?

† Ueber ein merkwürdiges Volk des Kaukasus, die Kubetschi. Von C. W. Fraehn.

‡ *Beytrag zur Geschichte des Afghanischen Stammes der Jusafsey.* Von B. Dorn.

may be judged by only recollecting that the late Mr H. T. Colebrooke, one of the most distinguished scholars whose names are known in connection with Indian literature, appears really to have supposed all the languages of India to have been derived from the Sanskrit, and to be nothing else than degraded or much corrupted Prakrits, or popular dialects of that ancient speech. It was first shewn by Mr Ellis, in his preface to Campbell's Grammar of the Telügü, that this opinion was very erroneous, and that the principal languages of the Dekhan, the Tamul, the Telügü, the Malayalam or Malabar, and the Tulava, as well as the Karnataka, the idiom of the central table-land of the Peninsula, are all dialects of one primitive speech, which is quite distinct from the Sanskrit. All these idioms are languages of the civilised nations. The memoirs of General Briggs and other recent philologists, comprise further researches into the history and languages of the rude hill-tribes, such as the Bhils, the Tudas, and the Curumbars of the Nilgherry hills, and other races inhabiting remote and secluded tracts; and the general opinion seems to be, that all such races are akin to the Tamulian or aboriginal Deckhany stock. The notion, which formerly prevailed in India, respecting the Bhils and the other hill-tribes, was different from this, and may still be true to a certain extent. The Bhils were supposed to be the descendants of outcasts and runaways, or persons who had at different times made their escape to the mountains, in order to elude the penalty of crimes, or avoid persecution or tyranny in the low countries. In such a country as Hindustan, divided into numberless petty sovereignties, each under the sway of its tyrannical despot, and where the institutions of society are otherwise most oppressive, there must be a great number of persons continually driven to seek refuge beyond the reach of the reigning tyrant. In most half-civilised countries something of this kind is observable. I have been assured by Dr Andrew Smith, one of the best-informed and most enlightened travellers who have lived among the people of South Africa, that in that country every tribe of the native *racés, who have submitted to social regulations, however imperfect, and have acquired some wealth by the cultivation of*

the soil or by pasturage, have, in their immediate neighbourhood, hordes of outcasts or refugees who hover on their borders, and live by depredation, or on the precarious produce of the chase, or the spontaneous fruits of the earth, roaming through forest and desert places. The Bushmen are thus the outcasts of the Hottentots; and Dr Smith has clearly proved that this is the real origin of the Bushman race. Many tribes of Kafirs have also hordes of outcasts answering to the Bushmen in their vicinity, who rob and plunder strangers, and wander in pursuit of an uncertain livelihood. The Fingoes, who were subject to the Kosah Kafirs, appear to have been a tribe of this description. Civilised nations, like those of Europe, imprison or put to death unruly people, who cannot be kept in subjection to the laws of society, or they transport them beyond seas; a greater number transport themselves to the colonies and elsewhere. But in countries such as those to which I have alluded, there is no similar resource. The outcasts from among the Hindoos take to the hills; and thus they have greatly augmented, though they have perhaps not in the first instance, given rise, to the hordes of Bhils and Goonds, and other mountain tribes. Where no distinct language can be found in use among the people, which is said to be the case in some extensive mountain-districts, it is perhaps most probable that they are chiefly the descendants of refugees. No complete or sufficient series of inquiries has yet been set on foot, with a view to the comparison of the languages of the mountain-tribes with the idioms of the civilised nations of India, though some attempts have lately been made, which prove the necessity of this investigation before we shall be entitled to draw any positive conclusions as to the relation between different tribes. The results will probably be different in the various parts of India. The idiom of the Tudas in the Nilgherry hills has been partially studied. It is said to display indications of affinity to the Tamulian. It would appear from a very curious paper in the *Journal of the Geographical Society of Bombay*, for 1846, by Mr Bradley, that the language of the Ghonds of the Guavil hills, has many words common to it and the idiom of the Orang Benua, who are supposed to be the aboriginal inhabitants of the Ma-

layan Peninsula, and the stock from which the Malays of the Eastern Archipelago originated. If this observation should be confirmed by future and more ample investigation, it would lead to an important result in ethnology, as it would not only establish a connection between the native tribes of the two Peninsulas of India, so termed, but would bring nearer to the centres of human migration the stock of that family of people who have spread themselves over the most distant islands of the great Pacific.

I shall take this opportunity of observing that many late writers appear to be under a mistake, who speak of the aboriginal tribes of the Dekhan, as belonging to races who approximate in physical characters to the Negroes or to the Papuas. There are great varieties in the stature and bodily constitution of different tribes inhabiting the various climates and localities of that great country. Some are diminutive and of dark complexion. These are principally the natives of low districts near the great rivers. But even these have no resemblance to the African type; and the Tudas of the Nilgherry hills are a remarkably fine and handsome people, as any one may be convinced who looks at the beautiful portraits of individuals belonging to this race, which are to be seen in the rooms of the Royal Asiatic Society of Great Britain.

Some difference of opinion has arisen respecting the origin of the languages of Northern Hindustan. They have been long supposed to be dialects of the Sanskrit, nearly in the sense in which French, Italian, and Spanish, are termed dialects of Latin. This was believed at one time to be the case of all the Indian languages; but since the idioms of the Dekhan have been recognised as belonging to a different family, the modern dialects of proper Hindustan, including the Hindi, the Punjābi, and the Bengāli, have still been regarded as legitimate descendants of the ancient language of the Brahmins. It has been contended, however, by Dr Stevenson, that these northern languages are in their fundamental structure barbaric or un-Sanskrit (if such a word may *be tolerated*), and that the Sanskrit portion has been added *to them as a foreign element*, nearly as it is supposed to have

been added to the Telügü and Tamul. The opinion of Dr Stevenson has been strongly opposed in a very able memoir by Dr Müller, which was read at the last meeting of the British Association, and has been printed in the Transactions of that Society. Dr Müller has proved, if I am not mistaken, that the Bengáli originated as a popular modification of the refined and elaborate Sanskrit, and he has suggested good reasons for extending this inference to the other northern languages of India. The race of the Hindoos themselves, at least the higher castes, or the so-termed twice-born tribes, who call themselves Aryas, must be looked upon as genuine descendants of the Arian conquerors of India, and of one kindred, as Dr Müller suggests, with the Indo-European nations, including the present rulers of Hindustan.

A very interesting contribution to Eastern Ethnology has lately been made by Mr Hodgson, well known by his writings on the Buddhistical books, which he collected while resident in the territory of Nepál. Mr Hodgson has lately transmitted to the Asiatic Society of Bengal a memoir on the various tribes of Bhotiyan origin who inhabit the mountainous tracts and the intervening valleys under the eastern part of the Himálaya, from the river Kali or Gagre, well known as a great ethnological boundary, eastward to Sikim. All these countries intervene between the elevated line of the snowy mountain-chain and the plains of Hindustan. Mr Hodgson terms them the Sub-himálayas. He says that the best illustration of the Himálaya and the Sub-himálayas is by a comparison with the skeleton of a human body, the former being analogous to the spine, and the transverse ranges termed Sub-himálayas to the ribs. The races of people inhabiting the Sub-himálayas are, according to Mr Hodgson, nearly related to each other, and they are all descended from the people of Tibet or Bhöt, the original abode of the Bhotiyan race. They are supposed to have crossed the line of the Himálaya from Tibet about thirty-five or forty-five generations back, or from 1000 to 1300 years ago. The transit was made before the Tibetans had adopted from India the literature and mythology of Buddhism, which they are supposed to have received in the

seventh or eighth century of our era. This fact, according to Mr Hodgson, is as strongly impressed on the rude languages and rude superstitious tenets of the Sub-himalayan tribes, as is their Tibetan origin on their peculiar forms and features. The proof of the affinity of all these tribes is to be found in their languages, of which Mr Hodgson has given a considerable specimen, such as may enable us to form some judgment as to the validity of his conclusions. The same paper contains interesting observations on the physical characters of the several tribes, illustrated by a portrait of Phu-chang, a native of Diparchi, in Utsang or Central Tibet, which is given as a specimen of the Bhotiyan physiognomy. The Tibetans are well known to be a race having the broad-faced Turanian or Tartar (Mongolian) physiognomy. The paper contains some remarks, which are important in a physiological point of view, on the permanence of physical types, as well as on the variations which display themselves in these branches of a peculiar race of people who migrated many centuries ago from their original country into one of a different climate, and who, therefore, live under different physical conditions from those to which the tribe was long subjected, and under the influence of which their brethren beyond the Himálaya continue to exist.

I must not omit to mention that a new portion of Professor Lassen's great work on Indian history—his "*Indische Alterthumskunde*"—has lately appeared from the press at Bonn. In this work the learned author has gone at great length into the questions connected with the ethnology of India, and his book is altogether one of the most instructive and elaborate publications connected with the history of that country that has yet appeared. Professor Lassen is well known as a most distinguished oriental scholar, and as one of those men who have with the greatest success devoted themselves to the cultivation of Sanskrit literature. We must always except the greatest master of the Sanskrit language who has lived since the age of Valmiki, at least among those who are foreign to the lineage of Brahma—I allude, of course, to the *Boden Professor*. Lassen's principal object seems to be the *history of the early periods of India*, which have been less

fully treated of by the Hon. Mountstuart Elphinstone, whose principal scope is the history of times subsequent to the invasion of Mahmoud of Ghizni and the Patan conquest. Before I pass from the subject of Indian history, I am bound to mention the publication of the Rigveda, under the direction of Professor Wilson, assisted by Dr Müller, to which Professor Wilson has promised to add an English translation. The Vedas are interesting, as displaying the most ancient form of the Brahminical religion: they are also valuable on account of the language in which they are written. This is said to be a dialect much more ancient than the classical Sanskrit, or the language of the Indian poems. A most curious circumstance in connection with the Vedic language is the relation in which it stands to the Zend, the idiom of the original text of the Zendavesta. It was long ago remarked by M. Eugène Burnouf, whose great work on the Yaçna shews how profoundly he has studied the scriptures of the ancient Magians, and the observation has been confirmed by Professor Wilson, that the Zend has a much nearer relation to the idiom of the Vedas than to the later and more polished Sanskrit. The Zend language is the greatest problem of eastern antiquity. If we suppose this language, as the fact just stated seems to argue, to have been coëval with the idiom of the Vedas, we must carry back the age of its prevalence as a living speech to the fourteenth century before the Christian era, since that is the date fixed upon by general consent as the period when the Vedas were composed, or perhaps compiled. But the writing of the Zendavesta, and even the invention of the characters in which it is written, is confessedly much more recent. It is apparently of comparatively modern date. Many learned men are of opinion that the greater part of the Zendavesta betrays otherwise indications of a late composition, and that neither the written character, nor the text of the Zendavesta as it now stands, can be more ancient than the elevation of the Sassanian dynasty. Major Rawlinson has observed that the compilation of the reputed works of Zoroaster, for which the Zend alphabet is supposed to have been formed, must have taken place at a period when the contents of the Cuneiform Inscriptions had

already faded from public memory among the Persians. "Otherwise," he says, the "priesthood could never have had the audacity or the desire to darken authentic history by allusions to the story of Jemshid and other fabulous personages, which occur in the Vendidad Sade and the ancient hymns of the Zendavesta, whence originated the romantic fables of the Shahnameh.' But if the different compositions which form the Zendavesta were first committed to writing as late as the age of Ardeshir Babegan, in what form can we suppose them to have been preserved during the sixteen or seventeen centuries which preceded, and which must be interposed before we can go back to the age of the Vedas, and the time when the Zend language is supposed, on the hypothesis above stated, to have been a national speech? The supposition that the priests preserved the whole of these long prose compositions in a language extinct, in their memory, exceeds the measure of belief.

We have had a very interesting contribution to the ethnology of Australia in a memoir by Mr Miles, who, during his residence at Sydney, where he is a magistrate, has availed himself of extensive opportunities of acquiring information respecting the habits and characteristics of the aboriginal people of the country. His paper, which has been printed, was read to the Ethnological Society during the last winter, and we have seen a specimen, sent us by the author, of Australian painting, viz., the impression in some real pigment of an open hand, which is seen in various places upon rocks, and which probably bears some symbolical meaning. We have also received a paper on the Natives of Eastern Australia from Mr George Burney. It was reported some months since that Mr Burnett, Deputy-Surveyor, who was sent on a journey of discovery for the exploration of the Bogue River in New South Wales, had lately returned, and we may expect some results from his expedition tending to the increase of our knowledge of the native tribes.

A new periodical work has been lately established under very favourable auspices, designed to elucidate the ethnology of the Indian Archipelago and the adjoining countries, including the maritime states in the Indo-Chinese Peninsula.

The editor is Mr Logan, a gentleman of great literary enterprise and zeal in the cause of science, who resides in a place of all others likely to afford opportunities for the extension of our knowledge respecting the objects of the publication, namely, in the new and thriving British settlement of Singapore. It is a journal published monthly, and commenced in July 1847. It is intended as a channel for communicating to European readers the past, as well as the contemporaneous discoveries of the Dutch in the Eastern Archipelago, who, in their different settlements publish much that is very little known in Europe, and likewise accounts from English and American residents in Borneo, Java, Bali, the Philippines, Siam, and other places. The parts already published of this journal contain many valuable papers, among which is a memoir on the Dyaks of Borneo, translated from the Dutch; an original paper on the Orang Benua of Johore, a race of wild people, who, in their physical character, resemble the Malays, and another on the Orang Sabimba, on the extremity of the Malayan Peninsula. It seems that the term "Orang," in the Malayan language is common to human beings and to apes. The authors of these papers inform us, that the above-mentioned tribes of human orangs differ greatly among themselves in physical characters, some having faces which are very narrow in the forehead, and very broad in the plain of the zygomata or of the cheek-bones; while in others the face is very narrow across the cheek-bones, and amazingly wide or broad above the eyes. The same journal contains translations of Temminck's account of the Dutch possessions in the Archipelago. In one number there is an interesting paper on the ethnography of Cochin-China, and a curious statement of the annual remittances which Chinese settlers at Singapore send to their families in China. It seems that the Chinese, whom we are accustomed to regard as possessed of few social virtues, have this good quality in a remarkable degree of making provision and personal sacrifices for the benefit of their relations and families. The settlers in Singapore remit large sums from the profits of their trade and parsimony to their friends in China, living themselves, year after year, *amid great privations*. We have been told in other quarters,

that the Chinese are led by this sentiment to a greater display of disinterestedness, and that persons condemned to be executed in the barbarous Chinese method can find substitutes, willing to undergo even capital punishment for the benefit of their families.

A Narrative of the Voyage of Discovery performed by Captain Blackwood, R.N., on board Her Majesty's ship *Fly*, written by Mr Jukes, the naturalist to the expedition, contains new and very interesting information respecting the native tribes of New Guinea, and some of the adjacent islands. I shall not attempt to extract the ethnological statements which this work contains, as they could not be compressed within a short space. The book is written in a very lively and interesting manner, and it is easy of access. The writer has given in many particulars a more correct account of the Papuas and other black tribes to the northward of Torres Straits, than we have before obtained. In regard to the Haraforas or Alfoers, a people about whom much has been written, but nothing until very lately accurately known, Mr Jukes coincides with the opinion communicated to me by my late friend, Mr Earle. I have already put into print the substance of this account.*

Numerous books have issued from the press, containing accounts of recent travels in various parts of Africa. One of the latest of these describes the journey of Mr James Richardson, who has visited some tribes of the Tuarek, of whom, previous to his travels, we knew only the names. A very curious book relating to *Soudan*, in the interior of the Continent, is the translation lately made by Dr Rosen, from the original narrative of Sheik Mohammed Zain-el-Abidin in Central Nigritia. We have no recent accounts of the Abyssinian nations, with the exception of a paper read by our enterprising and meritorious countryman Dr Beke, at the last meeting of the British Association, on the original seats of the Gatta, which the writer supposes to have been the country to the northward of the Mono-Moezi, in Eastern Africa. M. Anthony d'Abbadie is, as I believe, still in some part of Abyssinia.

* *Researches into the Physical History of Mankind*, vol. v.

The exile from that country of the learned and indefatigable Mr Krapf, has been contingently a fortunate event for the extension of our knowledge, since he was induced to seek a new sphere for his exertions as a Christian Missionary. Having fixed his abode in the country of the Suaheli, a comparatively civilised and trading people of the Kafir race, who occupy the coast of Ajan and Zanzibar, Mr Krapf has studied several of the languages of the native races ; and he has transmitted to the celebrated philologist, Von Ewald, materials which have enabled that writer to throw a new light on the ethnology of South Africa. Some recent notices of the Kafirs, near the Cape, are to be found in the narrative of Mr Bunbury, a very ingenious and intelligent traveller, who has visited the interior of the colony. The papers read before this Society, by Mr Daniel, contain many new and original observations on the native races of Kongo and the adjoining countries ; and Dr T. R. Heywood Thompson has contributed to extend our knowledge of the tribes of the more northern part of the same coast by two memoirs, which he has read on the Adiyah of Fernando Po, and on the Kroomen of the Grain Coast. Neither of these writers has added much, with the exception of Dr Beke, and the Rev. Mr Krapf, to African glossology ; but we may expect a great extension of our knowledge of African languages, if Mr Daniel should be preserved to return from his dangerous abode on the Gambia, whither he lately went with a firm determination to make extensive inquiries into the languages and history of the Fulahs, Mandingos, and other inhabitants of Senegambia, and Western Soudan.

I can say but little on the progress of American Ethnology during the last year. In the preceding year, a very learned essay was read before the Ethnological Society of New York, by Mr Bartlett, the secretary of that Society, on the progress of Ethnology. The second volume of the Transactions of this Society has not yet reached England ; at least I have not yet been able to obtain it from the American publishers, though it has been reported to have made its appearance in America. Some portions of it have, however, been received, *among which is an extensive memoir by Mr Schoolcraft, well*

known as a man of great ability, on the history of the nations belonging to the Great Algonquin or Lenapian family. It has been reported, that the venerable M. Albert Gallatin has completed his great synoptical work on the races of people forming the aboriginal population of North America, a work which, together with the luminous and critical investigation of the Mexican antiquities, by the same writer, places him in the very highest rank among those who have contributed to promote ethnology and the history of mankind. M. Gallatin is the only survivor of three great men, to whom we owe principally the exploration of North American Ethnology. Two of them, M. Du Ponceau, who was the leader of his countrymen in this pursuit, and the learned and accomplished Mr John Pickering, have already ceased to labour for the advancement of human knowledge. Taken altogether, the works of these writers comprise a great body of information on the Archæology of the New World, and form an imperishable monument to the literary fame of the writers and of their country. Their example has given an impulse which will continue to actuate their countrymen ; and we may expect a great deal from the researches of Anglo-Americans in those extensive regions which have lately fallen into the government of the United States. We have already heard, that a great mass of new information respecting the natives of New Mexico has been collected by Lieutenant Abert, a topographical engineer, who has lately returned from the Comanche territory. The opinion of the writer, founded on his own observations, is, that the tribes of New Mexico are of the same race as the ancient Aztecs ; and that the migration of the Aztecas from the North, into the valley of Anahuac, recorded in their ancient pictorial annals, was a real historical event. This opinion accords with that of Mr Ruxton, who read a memoir on the same subject during the last session of the Ethnological Society.

Some other contributions to American Ethnology have been made during the last year. There are several papers on American languages, chiefly those of the north-western part of the Continent, by our learned colleague Dr Latham, and others by Mr Isbister, which may be seen in the recently pub-

lished volume of the Transactions of the British Association. I may add, that the work of Commander Mackintosh, on the History of the River War of the Parana, in South America, contains some notices of the Guarani, the principal native race of Paraguay and the Brazilian countries.

I have now conveyed, though in a very imperfect manner, the recent progress which has been made in ethnology, in two of the separate paths pursued by the explorators of this department of knowledge. It remains for me to make some brief remarks on the investigation of ancient sepulchral remains, which I have termed *Palætophia*.

The sepulchral antiquities of various countries have long ago been examined with a view to the elucidation of ancient art, but no attempts have been made, until very recently, to throw light, by the medium of these researches, on the physical history of the several races of men. It now appears obvious, that, by this investigation, many questions connected with ethnology may be elucidated, since there are, in various countries, sepulchral remains of different periods, the relics of successive races of people who are known to have occupied them; and these remains may be distinguished from each other by the form of tombs, the modes of sepulture, and the relics of art, and by other incidental tokens which are discovered in them.

Several northern physiologists and antiquarians, Eschricht of Copenhagen, Professors Nilsson of Lund, Retzius of Stockholm, and Rudolph Keyser of Christiania, deserve our gratitude for having opened new views in the ethnology of ancient Europe, and for having led the way to a more careful and scientific examination of sepulchral remains than we had before contemplated. Professor Nilsson's great work on the contents of Ancient Tombs in Scandinavia is well known; and we were much interested in the curious memoir which was read by the author at the last meeting of the British Association.

The opinions of Professor Retzius were explained to us at a meeting of this Society, during the last winter, by Dr Santeson, his colleague in the same University; and a memoir was read on the same subject, by Dr Norton Shaw, to the British

Association. There are some minor points of difference between these northern ethnologists, but the main principles of their theory correspond. They mark two or three successive periods in the population of Europe; and they distinguish the relics belonging to each by certain craniological characters, confirming the distinction and the ascription of different degrees of antiquity to each by the modes of burial, the situation and description of tombs, and the remains of art found in them respectively. Professor Nilsson goes farther; he thinks that he has recognised a certain physical type in human remains associated with certain organic relics of animals, indicative of an ancient date in the history of the globe. The barbaric age of Scandinavia reaches back, according to Professor Nilsson, to the era of extinct animals, and to a period in which the surface of the earth was very different from what it has been since the commencement of historic times. Those ancient barbarians, the contemporaries perhaps of mammoths and mastodons, had skulls of a peculiar shape, and these skulls are found only in sepulchres containing implements of the rudest kind, made of stone, flint, bone, with ornaments of coral and amber. The ruder nations had, according to Professor Retzius, heads of a rounder form, having a shorter longitudinal diameter than those of the more cultivated people of later times, in whose tombs are found metallic implements, and ornaments indicative of greater advancement in arts. These last are the Dolicho-cephali or long-headed people of Retzius. Such are the inferences which very intelligent men have deduced from a survey of the sepulchral remains of northern Europe. How far they will accord with the results of similar researches in other countries we cannot as yet determine.

The subject of human races, and their division in the population of Europe, appears suddenly to have assumed an importance in public attention, which there was heretofore no reason to anticipate, since tribes and nations seem disposed again to break themselves up, and divide according to their races and languages. Races are made the groundwork of political coalitions, and a difference in stock and *lineage* becomes a plea for separation and hostility. If poli-

ticians come down into the ground of the ethnologist, they might condescend to receive a lesson from the science which he cultivates; and this would teach them that the mixture of races is often much more advantageous than their separation. Nothing is better established than that tribes and races of organised beings improve by the intermixture of varieties. A third stock, descended from any two races thus blended, is often superior in physical and psychical qualities to either of the two parent stems. The fierce indomitable spirit of one, mitigated by the more docile and tamer disposition of the other parent stock, produces a more generous and noble offspring. Facts which seem to establish this principle are well known in different provinces of the organised world; and corresponding observations have been made in the history of mankind. Without resorting to distant regions, we may observe that the English and French are mixed races. Who can say that our Saxon stock has not been improved by the mixture of other races engrafted upon it, or that the French, though partaking much of their old Celtic character, are not a great improvement on the original Celts. In mentioning the Celts, I am reminded of the allusions so frequently made in late times to the divided population of Ireland, said to be partly Saxon, and in a greater proportion Celtic; and I cannot withhold a remark, that a great mistake is connected with the prevalent notion on this subject. It is only by extending the meaning of the term beyond its proper and ancient acceptance, that we can call the Irish a Celtic people. I think it has been proved by evidence of the same kind, but perhaps much more abundant, and more easily collected, than that by which Baron William Von Humboldt elucidated the history of Spain, and marked out the extension of the Euskarians and of the Celtic inhabitants of that country, that the language prevalent through all Celtic Gaul, and all the Celtic countries on the Continent of Europe, was nearly related to the modern Welsh and Armorican, and but very remotely to the Erse. These two languages are often termed dialects of the Celtic speech; but they are not dialects of one language, though they may be termed sister languages. The analogy between them is rather comparable to that of the Latin to the

Greek than to the resemblances of really cognate dialects, such as the High and Low Dutch, the Spanish, Italian, and French, or the Polish and Russian. The Celtic were the people of Gaul, and of Britain. The traditions of Ireland uniformly deduce the people of that island from Spain, and ultimately from the east, and not from Britain or Gaul. Their language, in the phonetical structure of its words, is much nearer to the old Italic dialects, and also to the Sanskrit, than it is to the Welsh or Celtic. The Irish were a people greatly superior to the real Celts in poetical genius, and in all mental endowments, and after their conversion to Christianity, became one of the most intellectual nations in Europe, and were the civilisers of a part of it. We have no proof that their language was ever prevalent in Britain or in Gaul, where all the topographical names are easily explicable by a Welsh etymology, as are all the words of the Celtic language preserved by the classical writers. It is, therefore, a great mistake to speak of the descendants of Oisín and of Fingal, as if they were of the same Celtic lineage with Brennus, and the disciples of the Druids.

There is but one point of view in which ethnology comes into any relation to civil or political questions, and this relation is very remote, and a matter of doubt. It has been made an element in moral statistics. One of the celebrated writers on this science attributes the different proportions of violent crimes in different parts of France to the diversity of races in the population of that country. M. Quételet says, that within the limits of ancient Austrasia, where the population is in great part of German descent, there are fewer crimes against the person than in other districts inhabited by the descendants of the Celtic and Iberian races. This observation is worth recording, but when so many modifying influences are operating, it is impossible to estimate the efficacy of any particular cause in so remarkable a result.

On the Vegetation of the Carboniferous Period, as compared with that of the present day. By Dr HOOKER, Botanist to the Geological Survey of the United Kingdom.

(Concluded from vol. xlv., p. 369.)

As a field for botanical research, there is none so novel as the coal-formation; the few yards of shaft being more than equivalent to the longest voyage, in respect of the amount and kind of difference between the vegetation the naturalist is acquainted with, and that he seeks to understand. Whatever be the nature of the vegetation to which the botanist is transported, he commences by observing,—1. What are the orders, genera, and species, of plants characterising the Flora; their mutual affinities, and their relations to those of other countries; their numbers, and the relative proportions which the natural groups under which they arrange themselves, bear to each other. 2. The geographical distribution of the species, &c.; their extension over the surface of the country; and the replacement of one kind by another. 3. The relations which may be traced between the species and the soil, to which some are peculiar, whilst others are common to it and to very different soils; the quantity of moisture, heat, and light, they require, and the effects of a diminution or increase of any of these elements. 4. The reciprocal influence of the whole mass of the vegetation upon the surface it covers; the new soil, or alteration of the old, produced by its decay; the extent and composition of accumulations of dead matter; the particular kinds of plants contributing most largely to, and the consequent nature of, such deposits; the conservative influence of the vegetation upon this deposit, which may be retained by roots, and sheltered by foliage from the action of elements, which, in the absence of these protections, would rapidly sweep it away.

An enumeration of these points, viewed in their bearing on the subject of the Coal-Flora, will shew how limited is our knowledge of any one of them, compared with what might be acquired from a very superficial examination of any recent flora, or with what the geologist may obtain from any inspection of the animal remains in many strata.

1. Of the mutual affinities of the groups under which the majority of the genera of coal-plants arrange themselves, little more can be said, than that the *Ferns* occupy the lower end of the series, and the *Coniferae* possibly the highest; but this depends upon the view taken of the affinities of *Sigillariae*, the most important group. These are classed by some observers amongst *Ferns*; by others, with *Coniferae*; another considers them as linking these two widely-different families; whilst a fourth ranks them much higher than either. The affinities of another group, *Calamites*, are entirely unascertained. Of

the whole amount of species in each, no conjecture can be formed, or any but a very rough one of the number into which those with which we are familiar, as of common occurrence, should be divided. The Ferns far out-number, probably, all the others; but this again materially depends on the value, according to the markings of *Sigillariæ*, as means of dividing that genus; for if the slight differences hitherto employed be insisted upon, the number of the so-called species may be unlimitedly increased.

2. With regard to the geographical distribution of the species, &c., it appears that an uniformity once existed in the vegetation throughout the extra-tropical countries of the northern hemisphere, to which there is now no parallel; and this was so, whether we consider the coal-plants as representing all the flora of the period, or a part only, consisting of some widely-distributed forms that characterised certain local conditions. Nor is this uniformity less conspicuous in what may be called the vertical distribution, the fossils in the lowest coal-beds of one field very frequently pervading all the succeeding beds, though so many as thirty may be interposed between the highest and the lowest.

Of the relations between the soil and the plants nourished by it, little more is recognisable than that the *Sigillariæ* have been particularly abundant on the under-clay, which, judging from the absence of any other fossils but *Sigillariæ* roots (*Stigmaria*), seems to have been either in itself unfriendly to vegetation, or so placed (perhaps from being submerged) as to be incapable of supporting any other. The latter is the most probable, because both *Sigillariæ* and their *Stigmaria* roots occur in other soils besides under-clay, and are there accompanied by Calamites, Ferns, &c. The *Coniferae*, again, are chiefly found in the sandstones; and their remains being exceedingly rare in the clays, shales, or ironstones, it may be concluded that they never were associated with the *Sigillariæ* and other plants which abound in the coal-seams; but that they flourished in the neighbourhood, and were at times transported to these localities. The quantity of moisture to which these plants were subjected must remain a question, so long as some authors insist upon the *Sigillariæ* being allied to plants now characteristic of deserts, and others, to such as are the inhabitants of moist and insular climates. The singularly-succulent texture and extraordinary size of both the vascular and cellular tissue of many, possibly indicate a great amount of humidity. The question of light and heat involves a yet more important consideration, some of the coal-plants of the arctic regions being considered identical with those of Britain. How these can have existed in that latitude, under the now prevailing distribution of light and heat, has not been hitherto explained; they are too bulky for comparison with any vegetables inhabiting those regions at the present time, and of too lax a tissue to admit of a prolonged withdrawal

of the stimulus of light, or of their being subjected to continued frosts.

4. The consequence of the existence of the coal-plants has been the formation of coal; but how this operation was conducted is a question still unsolved. The under-clay or soil upon which the coal rests, and upon which some of the plants grew, seems in general to have suffered little change thereby, further than what was effected by the intrusion of a vast number of roots throughout its mass. The shales, on the other hand, are composed of inorganic matter, materially altered by the presence of the vegetable matter which they contain. The iron-clays, again, present another modification of this mixture of organic and inorganic matter, often occurring in the form of nodules. These nodules seem to be the result of a peculiar action of vegetable matter upon water charged with soil and a salt of iron, the iron-stone nodules of existing peat-bogs appearing altogether analogous to those of the carboniferous period, whether in form or in chemical constituents.

Here, then, the botanist recognises in one coal-seam a vegetable detritus under three distinct phases, and which has been acted upon in each by very different causes. In the under-clay there are roots only;* these permeate its mass, as those of the water-lily and other aquatic plants do the silt at the bottom of still waters.

The coal is the detritus either of those plants whose roots are preserved in the under-clay, or of those, together with others which may have grown amongst them, or at a distance, and have been afterwards drifted to the same position.

Above the coal is the third soil, bearing evidence of the action of a vigorous vegetation: this is the shale, which has all the appearance of a quiet deposit from water charged with mineral matter, and into which broken pieces of plants have fallen. Here there is so clear a divisional line between the coal and shale, that it is still a disputed point whether the plants contained in the latter actually grew upon the former, or were drifted to that position in the fluid which deposited the mineral matter. Amongst the shales are also interspersed, in many cases, innumerable stumps of *Sigillaria*, similar to those whose roots occur in the under-clay, and which are themselves found

* The absence of other parts of plants, and, indeed, of any plant but the roots of *Sigillaria*, in the under-clay, appears a fact of considerable importance. In the first place, it indicates that that soil was in a condition unsuited to the growth of other vegetables (as mentioned above) whose seeds might have accompanied those of that genus on its previously naked-surface. In the second place, this absence of other fossils in the under-clay is opposed to the theory of the drift-origin of the vegetable matter comprising coal: for there is no interstratification of coal with this subjacent deposit, which might have been expected to occur over some portion of an extensive coal-field; whereas the gradual decay of these plants, whose roots struck into the under clay, would produce a uniform bed of peat, perhaps adapted to the growth of those ferns and other plants which are fossilized in the superincumbent shales.

attached to those roots in soils similar to the under-clays, but unconnected with any seam of coal. These stumps are almost universally erect,—are uniformly scattered over the seams, and otherwise appear to have decidedly grown on the surface of the coal; the shales likewise seem deposited between these stumps. The rarity of *Sigillariæ* roots (*Stigmariæ*) in this position, is probably due to their being incorporated with the coal itself, though they sometimes occur above that mineral, and between the layers of shale. The seams of iron-stone (or black band) are the last modifications of soil by vegetable matter, to which allusion has been made: when these are uniform beds or layers, they may be supposed to be the deposit from water charged with iron and soil which has percolated through the peat, and in so doing absorbed a great deal of vegetable matter. The layers of nodular iron-stone are simple modifications of these, and may be caused by the sedimentary particles contained in the fluid, which, instead of being deposited in a uniform stratum, are aggregated round broken bits of vegetable matter (as fern-leaves, stems, or cones) which served as nuclei.

Now, though each of these points admits of some explanation when taken independently, and some illustration from the action of an existing vegetation upon soil, &c., it is very difficult to understand their combined operation over so enormous a surface, for instance, as one of the American coal-fields, and even more to account for their regular recurrence, according to some fixed law, in every successive coal-seam throughout the whole carboniferous formation. These are problems of the highest order, and unsuited to this sketch, the remainder of which shall refer to the plants themselves, and especially to those botanical characters according to which the Coal Flora has been grouped and named, and to an illustration of these several points, by a comparison of them with what are afforded of recent plants.

On the probable extent of the Flora of the Coal-Formation in Britain.

No fewer than 300 species of plants have been enumerated as belonging to the Coal Flora of Great Britain; but, whether this gives any approximation either to what was the amount of their species at one period, or even to all those which contribute to form the coal, it is impossible to say. It need hardly be observed, that a collection of the fragments imbedded in our most recent deposits is no index to the general mass of the vegetation, nor are the remains necessarily those of the commonest plants, or even of such as would *a priori* be judged the best suited for becoming fossilised. That hitherto unknown species do exist in an available state for the botanist cannot be doubted; they are of frequent occurrence; but that these are not so numerous as might be expected from the enormous magnitude of a coal-field, is evident from the great uniformity that prevails throughout the formation. It may indeed be a query, whether the

number of species still to be discovered will equal in amount that of the so-called species, which, being founded on imperfect specimens, will ultimately prove to belong to previously-described forms.

That the vegetation of the carboniferous period, whether confined to the coal veins or not, was highly luxuriant, cannot be disputed. The enormous bulk of carbon accumulated, and the prevalence of ferns in all the fields, and the great size to which so many soft-tissued plants attained, all prove this fact. A luxuriant vegetation is, however, no index to a varied one; and, as many of our modern woods, and even great areas of tropical forests, consist of but a few species multiplied *ad infinitum*, so may the forests of the carboniferous period have been composed of but a few *Sigillariæ* and *Lepidodendrons*, sheltering an under growth of a limited number of kinds of fern,* for a very limited number of them (comparatively speaking), if as protean as some of their allies are in our day, would embrace all the known species of the Fossil Flora.

In the temperate latitudes particularly, a recent Flora, marked by a preponderance of ferns, is almost universally deficient in species other orders; as is thus shewn. 1. Where one species prevails over a considerable area, as the bracken (*Pteris aquilina*) does in parts of Britain, and the *P. esculenta* in Van Diemen's Land and New Zealand, it generally monopolises the soil, choking plants of a larger growth on the one hand, and admitting no undergrowth of smaller species on the other. 2. A luxuriant vegetation of many species of ferns, continued through a great many degrees of latitude or longitude, especially in the temperate regions of the globe, generally indicates a uniformity of temperature throughout that area, and a paucity of species of flowering plants. A comparison of the vegetations of Tasmania and New Zealand illustrates this. The former of these islands, barely 200 miles long, contains four times as many species of flowering plants as New Zealand, whose total length is 900 miles. On the other hand, this latter country possesses more than four times as many kinds of fern as Tasmania, and they are so uniformly distributed over its area, that almost all those which are found at the southern extremity of the island, prevail also at the northern. The West Indian and Pacific Islands again present a flora, remarkably rich in ferns, and, in both these instances, we have very many of the species uniformly spread over an enormous surface, in the one instance, from the Windward Islands to Mexico; and, in the other,

* This preponderance of ferns over flowering plants is common to many tropical islands, and not confined to the smaller of them, as St Helena and the Society group. In extratropical islands, too, as New Zealand, I have collected as many as thirty-six kinds of fern in an area not exceeding a few acres; they gave a most luxuriant aspect to the vegetation, which presented scarcely a dozen flowering plants and trees besides. An equal area in the neighbourhood of Sydney (in about the same latitude), would have yielded upwards of 100 flowering plants, and but two or three ferns.

from New Zealand to the Society and Sandwich Islands. Take, on the other hand, the campos of Brazil, the sandy flats of Southern Africa, and the somewhat similar plains of Australia, and, sterile though they appear at first sight, they will be found to abound in many kinds of flowering plants; but unaccompanied with ferns.

This prevalence of ferns has been long adduced in proof of the climate of the carboniferous period being temperate, equable, and humid; and so it, no doubt, was; but I am not aware that it has been hitherto regarded as probable evidence of the paucity of other plants, and the general poverty of the whole flora which characterised that formation. If, however, the laws of existing vegetation are to be considered as having had equal force at that time when the fossil one flourished, we must conclude that the predominance of ferns in general, and of certain species of *Pecopteris* (a fern apparently allied to our *Pteris*), over a great area, together with the remarkable similarity of the English fossils with those of North America, are all indications that the flora of that period was poor in a number of species.

Let it not be supposed that this prevalence of an order, which, in point of complexity of structure, is low in the system of plants, is a fact favourable to the hypothesis that the vegetation of which it appears to form a large part, was less highly developed than what succeeded it. We know too little of the structure of the ferns of that day, to pronounce them either more or less complete than their allies of the present time; while of *Lycopodiaceæ*,* it may be safely asserted, that they were of a form and stature far more noble, and in structure more complicated, than any plants of that order now existing. (*Vide* vol. ii., Part 2, of *Memoirs of the Geological Survey of Great Britain*.)

On Dolomisation. By A. VON MORLOT.

A. Von Morlot states that the metamorphic nature of dolomite was first suggested by Arduino.† As early as 1827 W. Haidinger, in an article on pseudomorphism, described certain dolomitic pseudomorphs, and states that in their formation "part of the carbonate of lime was replaced by the carbonate of magnesia, so as to form in the new species a com-

* See "Essay on the Structure and Affinities of *Lepidostrobus*," in the present volume of Survey Reports.

† Osservazioni chimiche sopra alcuni Fossili. Venezia, 1779.

pound of one atom of each.'''* From this fact and other observations, he inferred that dolomite originated in a similar change. Elie de Beaumont, in 1837, suggested the same view, and thus accounted for the occurrence of open spaces in the dolomite, often amounting to twelve per cent. of the mass.

The association of gypsum with dolomite had been noticed by various observers. Haidinger, in view of this well-known fact, concluded that it must arise from sulphate of magnesia being the agent by which the change into dolomite was produced. The magnesia of the sulphate of magnesia going to a portion of the lime to form *dolomite* (or carbonate of lime and magnesia), the sulphuric acid thus set free would form with water and another portion of the carbonate of lime, *gypsum* (sulphate of lime).

But chemistry had shewn that when a solution of gypsum was filtered through pulverised dolomite, sulphate of magnesia was formed, and carbonate of lime set free. Haidinger had also observed the efflorescence of sulphate of magnesia in gypsum quarries, and traced it to a decomposition of this character. As these last are results of ordinary exposure, Haidinger naturally inferred that this *dedolomisation* required no unusual heat or pressure; while for the inverse decomposition (or dolomisation), both heat and pressure might be necessary. Experiments on this point were projected in 1843, by Haidinger and Wöhler, but were not carried out. Von Morlot has at last applied this test, and confirmed the view so far as to shew that when carbonate of lime and sulphate of magnesia in the requisite proportions are heated together under pressure, dolomite is actually formed, together with sulphate of lime. The temperature to which they were subjected was 200°C ., and the pressure 15 atmospheres. An interesting problem was thus solved.

[It is still a question, what is the least quantity of heat requisite for this dolomisation. Many compact limestones of our western states contain 30 or 40 per cent. of carbonate of magnesia, as first shewn by Mr. D. D. Owen; and these rocks present no evidence of the action of heat.

* Trans. Royal Soc. Edin., March 19, 1827.

In the analysis of recent corals, by Professor B. Silliman, junior, published in the volume on Zoophytes by the writer, there is less than one per cent. of magnesia. But in a compact coral rock, made up of material of coral origin, he found 38.07 per cent. of carbonate of magnesia. The coral rock was a result of consolidation without heat, as we may judge from the absence of all evidence of its effects. Another specimen of a fragmentary character afforded 5.29 per cent. of magnesia. Both resemble the common reef-rocks. They appear to shew that there are circumstances in which the magnesian salt of the ocean, and the carbonate of lime of the corals, may react and produce a magnesian rock at the ordinary tropical temperature of water. This action may favour the consolidation into rock, which is in progress beneath the sea-water. It is evident that the finer the coral or calcareous material, the more magnesian the product. This principle accounts for the small proportion of magnesia in the second case alluded to above.—J. D. DANA.]—(*American Journal of Science and Arts*, Second Series, vol. vi., p. 268.)

On Emerald Nickel from Texas, Lancaster County, Pa.

By Professor B. SILLIMAN Junior.

This is the same mineral which I have before described under the name of "hydrate of nickel."* The name now proposed is in accordance with the custom of giving a trivial name to mineralogical species, and has been suggested by my friend Professor C. U. Shepard, as peculiarly appropriate, from the brilliant colour and transparency of the mineral, resembling the emerald. The existence of carbonic acid in this mineral as an essential constituent, was overlooked by me, from the fact that it is all expelled at redness, and was therefore in my analysis put down as water. The water given off in the close tube does not change litmus paper, and the mineral does not effervesce in dilute cold hydrochloric acid. My attention was first directed to the probable

* *American Journal of Science and Art*, Second Series, vol. iii., p. 407.

existence of carbonic acid in this mineral, by a notice from Dr D. R. Thomson,* describing as a new mineral a carbonate of nickel from the United States, coating specimens of chromic iron. Professor Shepard also mentioned to me that he had found carbonic acid in the Texas nickel mineral, first described by me. I have, therefore, made a new analysis of the mineral in question, selecting the finest and most transparent coloured specimens in my power.

The following mineralogical description is mainly the same which I have before given, save that having much better specimens on which to determine the specific gravity, that now given may be regarded as more correct than the former determination:—

Emerald Nickel.

Massive, stalactitic, occurring in thin crusts on chromic iron. *Hardness* = 3 — 3·25, being but little above calc-spar. *Specific Gravity* = 2·570 — 2·693, two trials on different portions. *Lustre*, vitreous, brilliant. *Colour*, emerald-green. Transparent. *Streak*, delicate pea-green. Very brittle. Its pyrognostic characters have already been so fully described in the article first quoted, that it is useless to repeat them here; they differ in no respect from those of pure, artificial hydrate of nickel.

The water of this mineral is partially expelled at the ordinary temperature of a water-bath (212° F.); this fact led to estimating the total volatile product of the mineral too low, in the former description of this species. Carefully dried over sulphuric acid, the mineral lost, on two trials, 41·370 and 41·008; mean = 41·189 per cent.

The carbonic acid was estimated in the apparatus described by Fresenius and Will for analysing carbonates.

The mean of the three trials gave 11·691 of CO_2 . A trace of magnesia in the specimen examined was disregarded, as being accidental. The mineral rests on a basis of carbonate of magnesia, which is difficult to separate entirely.

The constitution resulting from the analysis is—

* Phil. Mag., Dec. 1847, p. 541.

		Atoms.
Oxide of Nickel, . . .	58.811	26.22 = 3
Carbonic Acid, . . .	11.691	4.23 = 1
Water, . . .	29.498	12.52 = 6

This gives the empirical formula, $3 \text{ Ni} + \text{C} + 6 \text{ H} = \text{Ni C} + 2 \text{ Ni 6 H}$, or $\text{Ni C} + 2 (\text{Ni H}_3)$.

When we remember the isomorphism of magnesia and oxide of nickel, it will be agreed by all who attach any value to this agency in modifying minerals, that we may have many cases in which these two oxides are mutually interchanged. Hence we find, at the Texas locality, dolomitic carbonates with a faint tint of green, derived from a small trace of oxide of nickel present in them; others of green colour several shades deeper; and others which closely approach the high colour and other properties of the pure hydrous carbonate of nickel described in this paper. In some specimens, unquestionable emerald nickel is found mechanically mingled with and coating whitish dolomite. I cannot agree with the opinion expressed by Professor Shepard, at page 250 of this volume, that these varieties are distinct species. Certainly we must demand analysis to shew that the Mg O and Ni O are in fixed atomic proportions with water, before the "hydrated carbonate of magnesia and nickel" can be regarded as a true species.—(*The American Journal of Science and Arts*, Second Series, vol. vi., No. 17, p. 248.)

On the Erratic Formation of North America. Letter from M. DESOR to M. DE VERNEUIL, dated Boston, November 7, 1847.

This letter of M. Desor appears to us destined to have a great influence on the numerous discussions undertaken, with a view to fix the origin of the erratic phenomenon of the north. Indeed, it furnishes us with a new and capital fact, namely, the association of marine shells with the polished and striated pebbles of the true *drift*. This fact was completely unknown till the moment when MM. Desor and De Pourtalès discovered it. The following is an extract from the letter :—

The erratic formation of America is composed of two stages, the *drift*, *amorphous* and without stratification in the lower part, and the

stratified clays and sands of the upper portion. The *drift* is a mixture of blocks, pebbles, sand, and mud, mingled without order. The pebbles and blocks are always rounded and covered with striæ. Although the geologists, MM. Rogers, Lyell, &c., who have examined this formation, have insisted that it contains no fossil, MM. Desor and De Pourtalis have discovered some in the neighbourhood of New York. The species are numerous; the principal are, *Venus mercenariæ*, *Ostrea canadensis*, *Nassa trivittata*, *Mya arenaria*, *Purpura floridana*, &c. They are all now living on the shores of the bay of New York, with the exception of a *Solecurte* which now lives on the coasts of the Carolinas.

The clays and sands which form the second stage of the erratic formation, have, for a long time, been regarded as tertiary, but M. Lyell having recognised them as younger, has composed his pleistocene formation of them.

These two stages occupy an immense space. We may follow them into the north and east of the Union, over a length of 1200 miles, without interruption. With regard to the level of the erratic phenomenon taken as a whole, it rises almost to the summit of the White Mountains. We there find polished surfaces and blocks as high as 5500 feet; the extreme summit, however, 6300 feet in height, has neither blocks nor polished rocks. The *drift* rises to two thousand and some hundred feet.

The terraces on the shores of Lake Erie at 680 feet of elevation, appear to be the upper level of the pleistocene. It is said, however, to reach 900 feet in Canada.

M. Desor insists particularly on this, that the clays contain fossils very well preserved, that the same species are found in localities very remote from each other, and that they still live on the shores of America. The level of these fossils above the sea, which it is important to determine, is not everywhere the same. Along the coasts of Maine, it is from 70 feet to 80 feet; it rises in proportion as we advance into the interior of the country; on the borders of Lake Champlain it is about 220 feet, and at Montreal 500 feet. We must conclude with M. Desor, that one of two things has happened, either that the elevation which has caused the sea to retreat within its present limits, has been felt with variable intensity at different points of the Continent, or rather that the shells have lived at different periods at these different points, so that each of these regions has formed successively the shore where these shells were developed. However this may be, it follows, as an examination of the land of Scandinavia had already demonstrated, that the erratic phenomenon comprehends a long period full of important events.

No one in America disputes the changes of level which that Continent has undergone during and after the erratic phenomenon. But the whole of these phenomena are explained in three different ways; 1st, *The theory of waves of translation*, advocated by M. Rogers,

which consists in supposing one or more great waves coming from the north, caused by earthquakes. In this theory it is necessary to admit many of these waves at different times. This forms a great difficulty.

2dly, The theory of floating ice defended by M. Redfield. As polished surfaces are found at a height of 5000 feet, we are obliged, by this theory, to sink this Continent 5000 feet below its present level. Besides, there are striated and polished valleys so narrow that it is impossible that icebergs could have passed through them.

3dly, The theory of glaciers, which finds here, as everywhere else, advocates and opponents. These last object to it, the absence of high mountains; but the recent investigations of M. Agassiz have shewn that glaciers move forward, not in consequence of declivities, but in consequence of their mass. It must be admitted that it is glaciers of the nature of those of the northern zone, and not alpine glaciers, which have produced the phenomena in question.

M. Desor then devotes a few words to the succession of faunas since the erratic epoch, founding his observations on this, that it has been proved that, at this period, a great part of the American Continent was under water, and that the chains of mountains only, such as the Alleghannies, the Rocky Mountains, the White Mountains, &c., rose like islands above the waters. At this period, the fresh-water fauna, and particularly the families of fishes which form part of it, could not be developed like those of our own day; and M. Desor here endeavours to shew that these *lacustrine populations have a more recent origin than the marine populations.*—(*Bib. Universelle, June 1848.*)

*Report on the Timber Trees of Bengal.**

By Captain MUNRO, F.L.S.

I know of no better mode of supplying, as far as may be in my power, the information required relative to the timber trees of India, than by making a catalogue of the best of them, appending such remarks to each as my own experience and reading may enable me to supply.

1. *Teak*—*Tectona grandis*, Nat. Fam. *Verbenaceæ*.—Generally known to the natives as *Saguan* or *Segoon*, although in Central India two or three other trees are also called by the same name. The Teak when in flower is very pretty; and,

* Drawn up by Captain Munro, at the request of the Asiatic Society, for the information of the Military Board.

being so commonly cultivated, nearly all over India, is known to most Europeans. Although it thrives, to my own knowledge, in almost every portion of Hindoostan, it attains perfection in a few favoured localities only. The Teak forests of Malabar are well known. They are very extensive, and produce, according to experiment, finer Teak timber than any other forest. The trees generally grow in low hills of about 1000 to 3000 feet elevation above the sea. Moulmein is also noted for its Teak. I have seen large forests of the tree in Nagpore, and near the Nerbudda; the wood is very much used in that part of the country, and appears to be of a very superior description. In the Metcalfe Hall there is a very good specimen of Teak grown in the Botanical Gardens, which has been worked up into a table, and presented to the Society by the late Mr Robison. From experiments carried on by Captain Baker, and detailed in the first volume of "*Gleanings in Science*," it would appear that Rangoon, Bómbay, and Pegue Teak were almost of the same strength, but are far surpassed by the Malabar Teak. Captain Baker's experiments, which will be constantly referred to, were carried on with specimens of wood two inches square and six feet long. In these trials the average weight required to break the Malabar Teak was 1070 lb., whilst the other kind broke with an average of 870 lb. The extremes in these trials are very remarkable, indicating a very great difference in value of different specimens of the same timber; the specimen from Rangoon, breaking with 654 lb., and another from Malabar required 1162 lb. Teak will not bend so much as Sál or Soondree, and breaks with about the same weight as Sál. It is, therefore, easy to determine for what purposes Teak is best adapted. It is used, as is well known, for an infinite number of purposes in India. The experiment made by Captain Baker differs much from the results of Major Campbell's experiment at Cossipore, as detailed in the Transactions of the Society of Arts. The Malabar specimen seems to have been a bad one; but as many of the other specimens were from unseasoned wood, they are not so much to be depended on.

2. *Ghumbar, Gomar, or Ghumbarre—Gmelina arborea*, Linn.—This belongs to the same natural family as the Teak,

and is, indeed, very closely allied to that wood in appearance, with the grain rather closer, although much inferior in strength and elasticity. The best specimen broke, with Captain Baker, with 580 lb., and the worst with 500 lb. It is a common tree in most parts of India, generally found on hills about 2000 feet in height. It also grows in the Soonderbunds. The timber is supposed to resist water and worms better than Teak. As it will not bear much stress, it is commonly used for light work, such as the cylinders of drums, carriage panels, decks of budgerows, and turnery. Although more durable than many woods, and not subject to warping, it can scarcely be called a valuable timber; and, from its resemblance to Teak, might be used in mistake for that wood, where serious consequences would ensue.

3. *Dhamum* or *Dangan*.—This was discovered by Mr Griffith to be an undescribed species, and was called by him *Hemigymnia Macleodii*. Of the same order with the Teak, it is very dissimilar, in its great elasticity. I am not aware of any other locality for its growth than the forest about Sconie, between Jubbulpore and Kamptee. The tree has a peculiar appearance, and can be distinguished at a long distance in the jungle. I have seen excellent fishing-rods made out of it, and good-sized timber could be at times procured. I believe the timber to be excellent; but as, according to our present information, it grows at such a long distance from water-carriage, except by the Nerbudda, it cannot be looked upon as likely to be of much consequence in commerce. I imagine, from observation, the tree to be of slow growth, and that it would require thirty years to come to perfection, if it should be thought desirable to encourage its cultivation on the low hills which approach the Ganges. There is no good specimen of the wood in the collection of the Horticultural Society, and it would be very desirable to procure one.

4 and 5. There are two other woods of this family produced in Goalpara, *Chikaghumbaree*,—*Premna hircina*, and *Bukdholi*, *Premna flavescentis*,—which, from Mr Kyd's experiments, would appear to be very durable wood, but are not, I believe, possessed of any other valuable properties.

6. *Sál*.—*Vateria robusta*, W. and A.—*Shorea robusta*, Roxb.

—Nat. Fam. *Dipterocarpeæ*.—I believe I am right in saying that every tree belonging to this family is a valuable one, most probably, from all containing a considerable quantity of resinous juice, which is called in the various trees, *Dammar*, *Wood-Oil*, *Gum Anime*, *Piney Varnish*, *Ral*, *Dhoona*, &c. These trees are all fine ones, and in the forests of Malabar attain a stupendous height. In the Ghauts of Cong and the Neelgherries one kind is generally known to Europeans as the Buttress tree, and from growing within a short distance of the sea, with water-carriage from the foot of the mountains by the Calicut river, thus offers a supply of the most valuable timber for some time to come. The Sál itself is probably the best timber in India. Of ten experiments of Captain Baker, the mean weight required to break the wood was 1238 lb., and one specimen required 1304 lb. The tree is found in great abundance in the Murung forests, and in the whole belt of forest at the foot of the Himalayas, frequently growing, as the Teak does, over a great extent of ground, unaccompanied by any other tree. The Calcutta market is abundantly supplied with the timber, principally, I believe, from Gorrukpoore. It is undoubtedly a very valuable wood for some buildings, and for many parts of gun carriages, and, indeed, for almost all purposes on shore, where very strong, tough wood is required. It is heavy, the specific gravity being upwards of 1000, whilst Teak wood is about 720. The Camphor tree of Sumatra is closely allied to the Sál. Two species of *Dipterocarpus*, of the same family, under the native names of Mekai and Hoolung, are mentioned by Captain Hannay and Mr Masters, as producing fine timber in Assam.

7. *Toon*—*Cedrela toona*, Roxb.—This, with the mahogany, satinwood, Rohunna and Chittagong wood, all belong to the same natural family, *Cedrelaceæ*, affording very valuable timber. The Toon is a favourite wood with the carpenters of India, and works out very prettily; the tree has a wide range in the Peninsula of India, and, generally, throughout Nagpore, Bundelkund, and the lower ranges of the Himalayas. It is a very beautiful tree, and now adorns the sides of roads in every part of Bengal, particularly at Bhaugulpore and Monghyr; 800 lb. broke the specimen used in

Captain Baker's trials, and its specific gravity is 640. Captain Hannay describes three varieties of Toon in Assam, under the names of Hindooree Poma and Seekha Poma, and says, that although light, when once seasoned it is very durable, and some splendid boats are formed of it, particularly in the Dihong river, where it would seem to be in great abundance. It is mentioned by Lieutenant Nuthall as one of the woods of Arracan, under the name of Thit-ka-do.

8. *Mahogany*—*Swietenia mahogani*, Linn.—This, of course, is only known in India in its cultivated state, and sufficient has been done to shew that it can be grown with great success. The Horticultural Society are in possession of beautiful specimens, that have been worked up from trees grown in the Botanical Gardens, and which are supposed to have been forty-three to forty-four years old when felled. The cultivation of the tree ought to be encouraged as much as possible in the lower hills, for even in its native country the quality depends very much on the situation where the trees grow. On elevated rocky places, where there is but little soil, the wood is always of a better grain and superior texture; whereas in low, alluvial situations, however vigorous and luxuriant the plant may be, the quality of the timber is always inferior, more light and porous, and of a paler colour. Mahogany is said to be almost indestructible by worms or in water, and to be bullet-proof. Captain Franklin took with him to the Polar Seas boats of mahogany, as being the lightest, in consequence of the thinness of the planks, combined with great strength.

9. *Rohunah* or *Rooah*—*Soymida* (*Swietenia febrifuga*, Roxb.—It is also called *Kukhut Rohida* in the Nagpore jungles. I am not aware that this tree is found in Bengal, but it is very abundant in Nagpore, and also in southern India. I have had at Kamptee abundant opportunities of trying the strength and value of the timber, and believe it to be one of the best in India. It takes a high polish, and from its fine red colour is peculiarly adapted for furniture. There are specimens in the collection of the Horticultural Society of the wood sent from the Jungle Mehals.

10. *Chickrassee*, or *Chittagong wood*—*Chickrassia tabula-*

ris, c. 1. This wood appears to be very abundant in Chittagong and in Southern India, but I am not aware that it is applied to any other purpose than cabinet-making, for which it is admirably adapted. According to Mr Masters, this tree is known in Assam by the same native name as the Toon, namely Toona.

11. *Billo*—*Chloroxylon swietenia*—the Satinwood.—It is generally found in company with the *Rohunna*. It is, however, much rarer, but is deserving of greater attention than has been yet paid to it.

12. *Soondree*—*Heritiera minor*.—This tree, which furnishes a great portion of the firewood of Calcutta, belongs to the natural family of *Sterculiaceæ*, in which almost all the woods are very perishable; and indeed in one tree, the *Adansonia*, which far surpasses in size any that we are acquainted with, the wood passes into dust within twelve months of the felling of the tree. However, the Soondree, from Captain Baker's experiments, appears to be the strongest and toughest wood he tested. The mean of five experiments gave 1312 lb. for breaking. The specific gravity is much the same as Sál, 1030. Soondree is very generally used in Calcutta for buggy shafts, and is well adapted for all temporary purposes where strength and elasticity are required. It is also used for boats, boat-masts, poles, and spokes of wheels. I imagine the Soonderbunds derive their name from this tree.

13. *Sissoo*—*Dalbergia sissoo*, Roxb.—This, with *Dalbergia latifolia*, *Sitsal*, or Blackwood, and *Dalbergia emarginata*, or *Andaman sissoo*, all belonging to the same genus, composes a portion of the natural family *Leguminosæ*, notorious for its timber trees, some of which, in America, according to Martius, attain the gigantic size of being at the bottom 84 feet in circumference, and 60 feet where the tree becomes cylindrical. If Sissoo were a more durable wood than it is supposed to be, it would be the most valuable wood in the country. It is very strong, requiring a mean of 1102 lb. to break it, is very elastic, and has a specific gravity nearly the same as Teak, 724. The timber is seldom straight, and is therefore not well adapted for beams, but is much employed for furniture, ship-building, and other purposes, where curved

timber is required. It is not proof against white ants. The tree is found all over this Presidency, either cultivated or in its native jungles, but is rare in Southern India. *Kunkur* appears to be prejudicial to it, for, in the neighbourhood of Agra, as soon as the roots reach the *Kunkur*, the tree which up to this time had been quite healthy, suddenly dies off. The Calcutta climate seems to agree very well with the *Sis-soo*, as there are some magnificent trees in the neighbourhood.

14. *Sit Saul*—*Dalbergia latifolia*.—This is called Blackwood and Rosewood, and sometimes, when well worked, is fully equal to the finest description of the rosewood of commerce. The tree attains a larger size in Southern India than it does in these provinces, and the wood is more commonly used there. The tree is common in Central India, and also, I believe, in Assam. I imagine the "black rosewood," mentioned by Captain Baker, to be this wood, and if so, its specific gravity is 875, and it requires 1196 lb. to break it. It is a remarkable fact, that up to this date it has not been ascertained to what tree we are indebted for the "rosewood" of commerce.*

15. *Peet Sal*—*Pterocarpus marsupium*.—This, with *P. santalinus*, Red sandalwood, and *P. dalbergioides*, Andaman redwood, are those magnificent trees, of which very fine specimens are to be seen in the Botanical Gardens, and also in the Barrackpore Park. The most prettily-shaped tree in the Park is *P. marsupium*. *P. dalbergioides* flowers in the gardens in July and August, and spreads its delicious fragrance for a long distance round. One tree is a most superb one, out-topping nearly every tree in the garden. The two other species are abundant in the jungles of Central and Southern India. *P. marsupium* is believed to produce a variety of the Gum Kino. It is universally known in Central India as the Hyissar, and is very strong, tough, and durable wood, perfectly impervious to insects of any kind. From its waved grain, it makes very handsome furniture. Its good proper-

* The valuable rosewood of the cabinetmaker, according to Professor Lindley, is from a species of *Jacaranda*; but this does not appear to be well made out.—EDIT.

ties seem to be valued by the natives of Nagapore only. There is no specimen of the wood that I know of in Calcutta; but it can, of course, be easily obtained. I have made very numerous trials of this wood, and am of opinion, that it is the best wood in India, combining, as it does, strength, lightness, and beauty, and it is easily procurable of very large dimensions. I have seen it very generally used for door and window frames; but it is curious to observe, that the plaster in its proximity always becomes more or less stained with a red colour. The finest trees I observed in their native jungles always grow in the stony bed of nullahs, a favourite locality of many leguminous trees.

16. *Seriss*—*Acacia serissa*.—This genus also contains *A. arabica*, *Babul*, and *A. catechu*, *Kaira*, producing timber. The *Seriss* is a dark-coloured very hard wood, approaching *Sissoo* in appearance and properties, but with the advantage of not being so liable to injury from insects. It is heavier than *Sissoo*, and broke with 709 lb., and is not quite so elastic. It is a fine, handsome tree, and to be found all over India growing in the plains. The wood is principally adapted for furniture.

17. *Babul*—*Acacia arabica*.—This is a very useful, strong, tough timber, used for knees and crooked timbers in ship-building, for the axles of country-carts, handles of mallets, and various agricultural implements; and, indeed, for all purposes where tough, small, plain wood is required. If it attained to any size, it would be extremely valuable. The tree grows well in every soil, and is well known to every person who has travelled in India.

18. *Kheri*, *Kair*, *Kaira*, *Koroi*—*Acacia catechu*.—This tree is known wherever I have been in India, by some slight variation of the words I have given above. It is more valuable than is generally supposed, and when a large tree can be obtained without much of the outer light-coloured wood, it is an excellent timber. It is very hard, and turns very well, being quite as close in grain as box, Kingwood, and other fancy woods, which command a very ready and remunerative sale in England. The tree is very widely spread over India, and seems to grow well even in the poorest soils.

The timber described as *Kerdun*, or *Keerra*, from Chota Nagpore, and so favourably reported on by Major Goodwyn, most probably is the same. Captain Tickell, in forwarding the specimens, says,—“ It works easily and smoothly, does not chip or crack by the weather, and the grain is so fine, that the smallest work with the highest polish could be done in it.”

19. *Kendoo—Ebony*.—There are several kinds of ebony in India; in fact there is no part that does not contain at least two or three different species of *Diospyros*, all of which produce more or less black wood, but *D. melanoxylon* is superior to any other. I imagine there is no wood more durable than ebony, and no insect can do it any harm. I refer only to the heart of the tree; the outside wood, which composes the largest parts of many trees, is attacked immediately by all kinds of insects. In Central India, where the ebony grows to a large size, and is very commonly used for beams in houses, a large tree is cut down and left for a year, when it will be found with all the light-coloured wood eaten away, and the hard and durable ebony alone left; carpenters are very loath to use the wood, as it injures their tools very much, and with many the fine particles which come off in the working, cause intolerable sneezing. Every one is aware of the beauty of ebony, if well polished, but few perhaps imagine that it is to be procured in such abundance as it is. It is to be found in every jungle of India.

Ablooya, *Kyan*, *Gáb*, *Oorigab*, are all known native names for different species of good useful ebony. All these trees are species in the neighbourhood of Calcutta, and some very fine trees of the *Kyan*, *Diospyros tomentosa*, occur at Allipore. The *Gáb* is known and used as a paying substance for boats by all natives; and it will very probably be found that *Gutta Percha*, which in time must become one of the most valuable exports from the Straits of Malacca, is a species of *Diospyrus*.

20. *Jarool—Lagerströmia*.—This is the pretty tree that so ornaments most of our woods with its beautiful light purple flower in June. There appears to be very various opinions regarding the merits of the wood as such, which, while one variety is strongly recommended, another is equally strongly condemned. It is, therefore, necessary to be very cautious in

using it. Captain Baker writes of Red Jarool as a fine wood, growing to a great size in Chittagong, but brought to the Calcutta market too small to be of much use except for picture-frames and other similar purposes. The Chittagong forests are said to be nearly cleared of the best, a thorny species of Jarool; the others are of little value. It is considered a valuable wood in ship-building. Hamilton describes it as growing of six feet girth in Goalpara, much used in building, but soft. Captain Hannay, in describing the wood in Assam, says it is well known at Dacca, and is admirably adapted for that portion of boats under water; and, well seasoned, it is a good wood. This Jarool is very scarce. I have seen the tree growing to a great size in the forests of Malabar, where it is not much esteemed.

21. *Assun*—*Terminalia tomentosa*, W. and A.—*Arjun*, *Arjuna*, W. and A.—*T. bellerica*, *T. calappa*, &c., &c., but often for their great size very useful. Hari is a common name of the different species amongst the natives. They are to be found all over India, and generally valued where they grow. Roxburgh mentions one species as growing to such a size as to be made into solid wheels for Buffalo carts. The Assuns were found, by Captain Baker, to surpass every other tree in elasticity, to break with 903 lb., with specific gravity of 986. Captain Hannay speaks in the highest terms of two species, but he describes the wood as very light; whereas, from the specific gravity mentioned above, it is evidently a very heavy wood; he says the wood has the quality of standing the weather well, and kept constantly in water, to harden and get black coloured. It appears to me admirably adapted for oars and ship-spars.

The above are, I believe, the most valuable timber trees in Bengal, and the number is indeed a large one, to which I could have added as many more, nearly as good, plainly shewing that there is no country in the world to surpass this in its timber produce. I regret much that my approaching departure for England renders it impossible for me to make this list as complete as I could have wished. The subject is a deeply-interesting one, and having paid great attention to it in India, I hope some little advantage may have been de-

rived from my observations. There are several trees, no doubt, possessed of equally valuable properties, but they are only known by uncertain native names. I would respectfully suggest that Government be requested to direct their officers, located in favourable positions, to send in leaves, flowers, and fruit of the trees reputed in their neighbourhood to be useful for timber. As it may be seen above, that peculiar uses seem to run in the same natural family, a botanist could, in every case, indicate the probable valuable of the timber. I would observe that it is a well-known fact, that wood grown in hilly countries is far superior to that grown in the deep soil of the plains. The trees are longer in coming to perfection, and mature their juices more slowly and solidly. This is particularly exemplified in the Sandal wood, which never is possessed, in the plain, of the good rich scent that it has when growing in the hills of Mysore, about 2000 feet above the sea. The Cedar of Lebanon also, which I believe to be identical with *Cedrus deodar* of the Himalayas, is almost valueless as a timber tree, unless grown in rocky, stony places, where there is but little soil. It is very remarkable to observe the difference of the quality of the Deodar wood which is grown on the south side of the snowy range, from that produced in Kunawur, on the precipitous sides of the Sutledge. Another remark I would particularly call attention to, is the felling of timber at the proper season when the sap is at rest. It requires no botanist to point out when this is to be done; although the leaves do not fall off in India, as in more temperate climates, it is impossible to find any difficulty in deciding, from the appearance of the tree, when the time for felling has arrived. When the sap is rising, the leaves are generally somewhat soft and perfect. When it is at rest, the leaves are harder, and, in India, almost always corroded by insects. In consequence of the facility of barking a tree when the sap is rising, oaks are often felled at this season in England, always with disadvantage to the timber, and this same facility of barking may also be an inducement to others in this country to fell timber at improper periods of the year. —(*Journal of the Asiatic Society of Bengal*, No. xi., New Series, p. 1.)

*Decomposition of Substances by Steam, and Manufacture of
Sulphate and Muriate of Potash.*

The most interesting and probably the most valuable of the patents granted during the last year, under the subject of chemistry, are two which have been granted to an American citizen, now residing in England. One is for the manufacture of sulphate and muriate of potash from feldspar, and the other for decomposing alkaline salts by the action of steam at a high temperature. The latter appears highly interesting, as a purely scientific discovery, apart from its practical value. In this exhibition of the solvent power of steam, we see at once a new, powerful, and most economical chemical reagent.

In the process of decomposing feldspar, the inventor heats together a potash feldspar, lime, or its carbonate, and the sulphate of either lime, baryta, or strontia, and afterwards lixiviates the mixture with water. The heat is to be kept at or above redness. In obtaining the muriate of potash, the muriate of either soda, lime, or iron is added to the potash feldspar, in place of the sulphate above mentioned, the *modus operandi* being substantially the same as in obtaining the sulphate.

The process of decomposing salts by steam is so replete with interest and novelty, as to warrant the citation in full of its description by the inventor:—

My invention consists in a method of decomposing the sulphates and muriates of the alkalies and alkaline earths, by exposing them at a high temperature to a current of steam or vapour of water, by which the acid is carried off, and the alkaline base either remains free, or enters into combination with some third substance provided for that purpose.

To decompose sulphate of lime, and obtain from it sulphuric and sulphurous acids, and free lime, I proceed in the following manner: I have a fire-clay cylinder of close texture, and of any convenient size, placed vertically in a furnace, and provided with openings at the top and bottom, for charging and discharging, which openings are capable of being closed air-tight. To the top of this cylinder I adapt an escape tube of fire-clay, for conveying off the acid vapours; and to the bottom for the admission of the steam, I adapt another clay-pipe, connected with a steam-boiler, by a series of fire-clay tubes, which are to be kept at a red heat. In order to diminish the corrosion of the cylinder by the sulphate of lime or the lime itself, I line it with a coating of native carbonate of magnesia, applied in a manner similar to the usual clay-linings of chemical furnaces. I fill the cylinder with pieces of sulphate of lime, about a quarter of an inch

in diameter, and having luted the openings air-tight, I heat the cylinder and its contents to a high red heat. I then pass steam from the boiler, through the red-hot clay-tubes, into the bottom of the cylinder, and up through the charge. The heated steam, in its passage through the pieces of sulphate of lime, carries off the acid in the state of sulphurous acid and oxygen, with sometimes a little sulphuric acid mixed with it. The acid vapours pass off by the escape-tube at the top of the cylinder, and I convey them by stoneware tubes into a leaden chamber, in order to combine them into sulphuric acid by the usual means. I take care that the heat is not raised so high at first as to melt the sulphate of lime in the cylinder, but I increase it towards the end of the operation, the charge becoming more infusible when partly decomposed. I have an opening in the tube conveying off the acid vapours from the top of the cylinder, by means of which I examine the vapours from time to time, and from the relative acidity of these, ascertained by the usual tests, I judge of the progress of the operation. I regulate by a stop-cock the quantity of steam passed through the charge in the cylinder, maintaining the supply at that point which produces the greatest quantity of acid in the vapours. When the vapours cease to contain any notable proportion of acid, the cylinder and its contents being at a high red or low white heat, I shut off the steam, withdraw the charge from the cylinder by the lower opening, and put in a fresh one to be treated like the first. The charge thus operated upon will be found to consist chiefly of caustic lime. When I wish to obtain the acid and alkaline base from the sulphate of magnesia, I first drive off by heat all its water. I then introduce it, in small pieces, into a cylinder such as I have before described, and operate upon it in the manner directed for the sulphate of lime. But I take care to keep the heat at low redness at first, to prevent the fusion of the charge, which would choke up the cylinder and prevent the passage of the steam. The decomposition of the sulphate of magnesia takes place at a much lower temperature than that of sulphate of lime (a low red heat is sufficient), and a considerable part of the acid is given off in the state of sulphuric acid. When the charge has been treated as directed, the residue will be found to consist chiefly of caustic magnesia.

When I wish to decompose the sulphates of baryta and strontia, I operate upon them in a reverberating furnace. This mode is less advantageous for the manufacture of sulphuric acid than the use of the close cylinder formerly described; but I prefer it for the two last-mentioned salts, because I consider their bases the more important product of their decomposition, and the hydrates of these alkalis, and particularly that of baryta, being fusible, would have much tendency to corrode the interior of the cylinder, at the heat necessary to decompose the salts. I use a common reverberatory furnace, with its hearth covered with a compact bed of native carbonate of magnesia, 3 or 4 inches thick. Several clay steam-pipes are

introduced through the roof of the furnace, so as to throw a current of heated steam over the whole width of the hearth; these pipes are connected with a steam-boiler by a series of fire-clay tubes, kept red hot. The sulphate, broken into pieces of about half an inch in diameter, is spread over the lining of carbonate of magnesia on the hearth of the furnace, and brought to a high red or low white heat. A current of steam is then admitted from the boiler, through the red hot tubes, upon the charge.

The acid of the sulphate is carried off by the steam; and when I wish to condense it, the acid vapours are conveyed, along with the gases of the fire, into a leaden chamber, to be combined into sulphuric acid by the usual means. The quantity of steam thrown upon the charge is kept at the point which produces the most rapid evolution of acid, and the charge is stirred occasionally, so as to expose fresh surfaces to the action of the steam. As the contact of deoxidizing gases with the sulphate is injurious, I admit, if necessary, by suitable openings above the fuel, such an excess of air as will render the atmosphere in the furnace oxidizing. The sulphate of strontia requires a higher heat than the sulphate of lime for its decomposition, and the sulphate of baryta still higher than the sulphate of strontia.

When the sulphate of baryta is partly decomposed, the mass melts, and becomes more fusible as the decomposition proceeds. I judge of the progress of the operation by testing a portion of the charge from time to time: when it dissolves altogether, or nearly so, in dilute nitric acid, I withdraw the charge, which now consists chiefly of the hydrate of baryta or strontia. To obtain muriatic acid, and the hydrates of baryta or strontia, or caustic lime, from the muriates of these bases, I employ the same process as that above described for the decomposition of the sulphate of baryta.

The sulphates of potash and soda may to some extent be decomposed, by being subjected, at a high temperature, to the action of a current of steam, in the manner directed for the decomposition of the sulphate of baryta. But owing probably to the volatile nature of the bases of these salts at a high temperature, no large proportion of them can thus be obtained in a free state. To aid, therefore, the decomposing action of the steam, I employ some substance capable, when mixed with these sulphates, highly heated and exposed to steam, of forming a combination with their alkaline bases, which shall yet, when cold, give up the alkali to the action either of water or of water and carbonic acid.

Of the large class of substances possessing these properties, which for convenience I will call combining substances, I prefer to use either alumina or the subphosphate of alumina. The alumina is prepared by strongly igniting the sulphate of alumina, or by any other well-known process. The subphosphate of alumina is prepared (as directed in chemical works) by mixing solutions of the

phosphate of soda and the sulphate of alumina, and adding to the solution a slight excess of ammonia. I mix the alumina, in the state of powder, with an equal weight of the sulphate of potash or of soda, also powdered, and spread the mixture upon the hearth of a reverberating furnace, such as I have before described for the decomposition of the sulphate of baryta. The mixture is then heated, exposed to steam, stirred, and the operation conducted in all respects in the manner described for the treatment of the sulphate of baryta. When it is desired to collect the sulphuric and sulphurous acids produced by the decomposition of the sulphates of potash and soda, I prefer to moisten the mixture of alumina and the sulphate with water, and form it into balls about half an inch in diameter, which I heat and expose to steam in a close cylinder, in the manner formerly described for the sulphate of lime. When a specimen of the charge shews by the usual tests that it contains no notable proportion of sulphate undecomposed, the operation is completed. I then withdraw the charge, lixiviate it with hot water, and when the clear solution of aluminate of potash or soda thus obtained has become cold, I pass through it an excess of carbonic acid, until no more precipitate of alumina is formed. The clear solution of carbonate of potash or soda is then drawn off, and evaporated. The alumina thus recovered is again used as the combining substance. When I wish to obtain the aluminate of potash or of soda, I merely evaporate the solution above described, without introducing the carbonic acid.

The muriate of potash or of soda, I merely evaporate the solution above described, without introducing the carbonic acid.

The muriate of potash or of soda may also be decomposed when in a fused state by the action of steam; alumina or the subphosphate of alumina being present, the operation is to be conducted in all respects in the same manner as that just described for the sulphates of potash and soda. But owing to the great volatility of the muriates of potash and soda, when exposed at a high temperature to a current of air or steam, a large quantity of the muriate will escape with the steam and gases of the fire in the state of vapour undecomposed, and will be lost or will be difficult to condense. I prefer therefore to effect the decomposition of the muriates of potash and soda by causing their vapours, intimately mixed with highly-heated steam, to pass slowly through a mass of small pieces of alumina kept at a high red heat. I use for this purpose a vertical fire-clay cylinder lined with a coating of native carbonate of magnesia to diminish the corrosion of its sides by the alkali, and made with convenient openings at top and bottom, for charging and discharging, which openings should be capable of being closed air-tight. I arrange a cast-iron retort, so that its tube enters directly the cylinder near its bottom. The retort should have a charging door at the top, capable of being made air-tight, through which is introduced the muriate of potash or soda to be decomposed.

The muriates of potash and soda will not vaporise freely when fused and highly heated, unless the atmosphere above them is continually changed. This may be effected by a current of steam, and I find that I can sufficiently regulate the quantity of the salt volatilised from the retort, by the amount of steam which I blow over its melted surface. I therefore insert a small steam pipe into the top of the retort, so as to throw a jet of heated steam upon the surface of the melted salt, and thus force its vapour to enter the cylinder. The quantity of steam thus introduced to aid the volatilisation, is not sufficient to decompose all the salt volatilised. The rest of the steam necessary for this purpose is passed directly into the cylinder by a fire-clay pipe entering it near the bottom, and connected through a series of fire-clay tubes kept red hot with a steam boiler. Both steam pipes are provided with cocks; an escape tube is inserted into the top of the cylinder, to convey the acid vapour and the vapour of any undecomposed muriate into suitable condensers. I have an opening in this tube, by which I can withdraw at times a portion of the vapours in it, to examine their saline and acid characters.

The cylinder and retort are to be so constructed and arranged, as to allow their contents to be heated to high redness and upwards, by any of the well-known means. The mode of operating is as follows: The discharging door being closed air-tight, I fill the cylinder with alumina in pieces of about a quarter of an inch in diameter, and fill the retort with the muriate of potash or soda, and then close both the charging door of the cylinder and that of the retort air-tight. I now bring the cylinder to a high red or white heat, and the retort to a cherry-red heat, so that the salt in it is melted and ready to volatilise freely at the admission of steam upon its surface. Steam is now passed from the boiler through the red-hot tubes into the cylinder by the pipe entering near its bottom, so that it is filled with highly-heated steam passing upward in a slow current through the interstices of the pieces of alumina. I now admit, by degrees, a jet of heated steam into the salt retort, by the pipe entering its top, and thus drive a quantity of salt vapour into the cylinder, where it mixes thoroughly with the current of steam which has entered by the other pipe, and ascends with it through the column of highly-heated alumina. In its passage, the alkaline base of the muriate combines with the alumina, forming an aluminate of potash or soda, and the muriatic acid, together with any salt vapour which may have escaped decomposition, passes off with the steam through the escape tube at the top of the cylinder into the condensers provided. The progress of the operation can be ascertained by examining the nature of the vapours which are passing through the escape tube.

When these vapours contain a large quantity of salt, and are strongly acid at the time, I admit more steam through the pipe leading directly into the cylinder, and if this does not have the effect of diminishing the quantity of salt in the vapours, I lessen the quantity of

steam thrown into the salt retort, and by that means, decrease the supply of salt vapour driven into the cylinder. When the escaping vapours contain but little salt, and a large quantity of acid, I consider the operation as proceeding favourably, and I always endeavour to regulate the quantities of steam passed through the two pipes, and by that means, the proportions of salt vapour and steam thrown into the cylinder, so as to produce this effect.

When the escaping vapours contain a large quantity of salt and steam and but little acid, the cylinder and its contents being at a high red heat, I consider that the decomposition of the salt is no longer effected in the cylinder, and I then shut off both currents of steam, withdraw the charge by the lower door, and replace it by fresh alumina. The withdrawn charge is then lixiviated with hot water, and the solution of aluminate of potash or soda thus obtained is treated with carbonic acid, as before described.

The lining of the cylinder should be examined occasionally, and kept in repair, so that the fire-clay may not be corroded by the alkali. Provided the charge of alumina in the cylinder is readily and equally permeable to the current of steam and salt vapour, the smaller the pieces of which it consists, and the greater the surface they expose to the current, the more rapidly will the decomposition of the muriate proceed. The steam used need not be of a higher boiler-pressure than will suffice to secure its passage through the charge in the cylinder. The subphosphate of alumina may be substituted for the alumina, in the processes for the decomposition of the sulphate and muriates of potash and soda, and its action is even more powerful, but its first cost is greater. Although to aid the decomposition of the sulphates and muriates of potash and soda by steam at a high temperature, the use of either alumina or its subphosphate is preferred as the combining substance, yet there are a great number of substances which also possess the requisite properties, but act with various degrees of energy. Thus many salts which contain already a certain proportion of base, will yet, when exposed in contact with the sulphates and muriates of potash and soda, at a high heat, to the action of steam, form a combination with the potash or soda, decomposable, when cold, by water, or water and carbonic acid. The subphosphates of lime, baryta, and strontia, and the subsilicates of lime, baryta, and strontia, will, under these circumstances, combine with the alkali and yield it to the action of water alone when cold. The sulphates of baryta and strontia, although themselves decomposable by the action of steam at high temperatures, are still capable of thus aiding in the decomposition of the sulphates and muriates of potash and soda, and yield the alkali by the action of water. The neutral phosphates, and neutral silicates of potash and soda, when thus treated, form basic salts which are soluble in water and decomposable by carbonic acid.

The alkalies, lime, and magnesia, will also thus combine with a

portion of free potash or soda which may be extracted by water. Other materials are capable of being used as combining substances; but I have named these which I consider preferable.

The decomposition of the muriate of soda by the action of steam at a high temperature may be applied to the production of sulphate of soda, by exposing the muriate mixed with sulphate of lime to a high heat and to the current of steam. For this process I use a horizontal cylinder of close fire-ware, protected on the inside from the action of the lime or the sulphate by a lining of carbonate of magnesia, and provided with an opening for charging capable of being made air-tight. Into the top of the cylinder, at one end, a steam-pipe is introduced, and from the other end, at the top, an escape-pipe connects with suitable condensers for collecting the vaporised salt and acid. The cylinder is half filled with a mixture of equal parts by weight of sulphate of lime and muriate of soda, the opening made air-tight, and the cylinder and its contents brought to a red heat. A current of heated steam is then admitted, which passes over the surface of the melted mixture and carries off muriatic acid, with more or less volatilised salt, into the condensers. When the steam escaping from the cylinder ceases to contain any notable quantity of muriatic acid, the operation is discontinued and the charge is withdrawn. Its soluble salts are extracted by water, and the sulphate of soda separated from any undecomposed muriate by evaporation and crystallisation.

In this operation the heat should not be raised so high as to cause the decomposition by the steam of the sulphate of soda produced, or the sulphate of lime itself.

Though I prefer in all the above described processes heating the steam highly before passing it upon the salt to be decomposed, yet the same effect will be produced whenever the steam and salt are in contact at the proper temperature for the respective decompositions, whether they have both been previously heated, or one alone heated so highly as to be able to raise the other to the required temperature. As has been before stated, some of the salts are decomposable by steam at a much lower temperature than others, but with all the decomposition proceeds more rapidly in proportion as the heat is increased.

I claim as my invention the decomposing the sulphates of baryta, strontia, lime, and magnesia, and the muriates of baryta, strontia, and lime, by exposing them at a high temperature to the action of a current of steam, for the purpose of obtaining the acids and the alkalies of these salts respectively.

I also claim the decomposing the sulphates and muriates of potash and soda, for the purpose of obtaining the acids and the alkalies of these salts respectively, by exposing them at a high temperature to the action of a current of steam, alumina or the other combining substances being present.

I also claim making aluminates of potash and soda by the action of a current of steam upon a mixture of alumina and the sulphate or muriate of potash or soda at a high red heat.

I also claim the making sulphate of soda by the action of a current of steam upon the muriate of soda at a red heat, sulphate of lime being present as described.—*Patent-Office Report for 1847*. Washington, 1848, p. 57.—*The American Journal of Science and Arts*. 2d Series, vol. vi., No. 17, p. 260.

Remarks on the Succession of Organised Beings on the Surface of the Earth. By PROFESSOR F. J. PICTET.

The succession of organised beings on the surface of the earth is the principal question which palæontologists are attempting to solve; but they are far from being agreed as to the manner in which they ought to consider and understand the subject. It may even be said that the more they examine it, the greater tendency have their discussions to divide naturalists into distinct schools, schools which more or less correspond to those into which the individuals who have endeavoured to investigate the most important questions of zoology, anatomy, and embryology, have always been divided.

I should not revert to a subject which, of late years, has been treated of with such variety of detail, and on which I have already had an opportunity of expressing my sentiments, did I not think that, notwithstanding all that has been said upon it, there are still some questions connected with it, by no means placed in a proper light. The discussion of many of them has assumed too complex a character, so that the opponents often encounter each other with arms which miss the mark. I am convinced that there are a greater number of points than would be supposed, for which all the schools would have admitted the same solution, if the different aspects of the questions had been always looked at in a proper manner. I shall here, in particular, endeavour to shew that no one could deny, within certain limits, the law of the specialty of fossils, and that, among all the hypotheses open to discussion, the theory of successive creations is the only one that can be admitted, if we consider it only in its most general sense. The discussions and deviations relating to this law and this theory, can only, in my opinion, bear upon the extent which ought to be assigned to them in the application.

I think, therefore, that it will not be without advantage again to call the attention of palæontologists to some parts of these discussions. Theoretical views, it is true, are only the accessory and superficial polish of the science, facts constituting the essential part; but, in the present case, they have too direct an influence on theories not to assume a real importance. All who engage in the study of

fossil remains must form a notion, more or less precise, respecting their succession, and the opinions they have formed on this point necessarily react on their tendencies, their systems, and the manner in which they look for facts, and also group and explain them. A palæontologist who should confine himself to collecting facts without previously having formed some theoretical view, and who sought not, under its influence, to direct his observations to the elucidation of some obscure points in the history of the globe, would resemble a navigator who embarks without rudder or compass, and discovers new regions without having the means of determining their relations to the rest of the world. Facts which, as I have already said, are the useful part of the science, require some bond of connection in order to excite interest, and to render them worthy of becoming the objects of the philosopher's meditations. Although this bond of connection can scarcely ever be known with certainty, every one endeavours to aim at it, and seek for its discovery; and this he makes his principal, though remote, object. The time, therefore, is not lost which is devoted to the elucidation of this inquiry, and to the discussion of the probability of the laws and theories which facts alone, it is true, can convert into certainty, but which have an important influence on the manner of collecting, commenting upon, and generalising facts.

I shall first consider what relates to the *law of the specialty of fossils*, a law which, as every one is aware, consists in the admission that each geological epoch has had its peculiar species, and that no species is found, at the same time, in the formations of two different eras. This law has been keenly defended and attacked, and the importance of its geological applications sufficiently explains the interest which attaches to it.

In the first place, even the right of its bearing the title of a law has been disputed by a skilful anatomist, M. de Blainville, whose high authority, in subjects of natural philosophy, I most readily admit. I believe with him that the word *law* ought to imply the idea of a more immutable and necessary principle than belongs to the generalisations which the human mind draws from the study of the phenomena of nature: but in applying this name to the principle in question, palæontologists have done nothing more than follow the example which has been long set to them by natural philosophers, physiologists, &c. In all sciences, the general expression under which we assemble the conditions common to many facts, or the relations which observation seems to indicate between them, has been called a law; and if it be wrong to assimilate, in some measure, by this word, these incomplete and imperfect relations to the immutable laws of nature, the same blame may perhaps be attached to almost every thing that bears the name of law, either in the physical or natural sciences. The laws acknowledged by natural philosophers respecting the distribution of heat or the density of gases,

the laws of physiologists, known under the names of the law of epigenesis or the law of symmetry, and many others, have no more characters of necessity and certainty than the laws relating to the succession of organised beings. Let us acquit palæontologists, therefore, of the blame that has been imputed to them of excessive boldness in expressing the deductions they have drawn from the entire view of observed facts.

In discussing the question itself of the specialty of fossils, a great difficulty meets us at the outset, namely the impossibility of defining a species in an exact and sufficient manner. This difficulty is, perhaps, one of the principal causes of the confusion which has too much prevailed in the discussion of this law. In fact, we so little know what constitutes a species, that the use of this word necessarily entails some degree of vagueness and uncertainty. The definition of Buffon, De Candolle, and Blumenbach, and in general all the means proposed to throw light on the study of a species, have not entirely dissipated the cloud which still rests on the idea. These difficulties have even appeared sufficient to some naturalists to induce them to deny the reality of a species altogether, and to consider it a mere creation of the fancy. I cannot follow them this length, and I believe that a species exists in nature, maintained and preserved by indisputable physiological laws; but as to fixing its limits synthetically, or defining it precisely, this I consider almost impossible in the present state of science. If we endeavour to give an account of what a species is by analysis, the following appear to me to be the only facts upon which we can proceed.

Every organised being springs from parents, that is to say, from one or two beings similar to itself. Whether it proceed from them by simple separation, slip, stolon, bud, &c., or whether it be the result of true fecundation, the new being resembles that to which it owes its existence, and without being altogether identical with it, possesses all its essential characters. These characters, proper to the family properly so called, that is to say, to the father, mother, and offspring, always form a whole which it is very easy to distinguish. If the transmission of the characters always took place without modification, it would be easy to understand and define a species, for the direct comparison of two successive generations would resolve all doubtful cases; and the characters common to the family properly so called, being the same in all the beings proceeding from the same primitive couple, would always enable us to ascertain and establish this common origin, which would thus become a solid and certain basis for the species.

But things are far from always proceeding in this way, and various circumstances modify these facts, so simple in their origin. We remark, in the first place, individual varieties, that is to say, slight modifications of size, colour, temperament, &c., which direct generation does not always reproduce, and which increase in conse-

quence of the differences between the progenitors and descendants. Amongst these slight modifications, are some which, wanting in the parents themselves, may yet be transmitted by them, because their predecessors possessed them. The parents may, therefore, possess certain qualities in a latent and virtual manner, and give to their descendants a title to an inheritance derived from their forefathers. Thus two black dogs may have white descendants, if one of their own predecessors was of the latter colour. This is a law which has been long known under the name of *ætavism*, and which modifies a little our first and simple notion of a species by adding to apparent characters modifications which have lain dormant for some generations.

Among the accidental modifications exterior circumstances may produce, there are some which, in consequence of a continued influence on many generations, transmit themselves in the way of reproduction. Thus horses with heavy limbs and a lymphatic temperament, when conveyed to the dry regions of Arabia, are subjected to an influence which will gradually diminish the size of their limbs, dry their cellular tissue, make their heads smaller, and, after a certain number of generations, their direct descendants will acquire the characters of an Arabian horse. After a sufficient time, these qualities will be transmitted, even although the circumstances which produced them have ceased, and the descendants of these same horses, brought back to the humid climates of temperate Europe, will yield a progeny for some generations which preserve the marks of the prolonged influence of Arabia. Remarkable instances are mentioned of accidents altogether artificial reproduced in this way by generation, when they are repeated (always artificially) on many progenitors.* The new families (ascending and descending) modified by these circumstances, will differ in certain respects from the primitive type, and the groups into which the descendants, thus more or less modified and deviating from the common origin, are divided, are named *races*. We thus have a new and important modification of the first notion of a species, for the characters which limit it can no longer be recognised by the direct comparison of ascendants and descendants, but only by the study of a long series of generations, during which different types may have been formed.

The history of races presents us with important facts. 1st, The individuals composing them are, in general, capable of uniting with those of races proceeding from the same common origin, giving birth to descendants which may themselves become the source of new beings. 2d, We observe in races which have deviated from the primitive type, a tendency to revert to that type. When the circum-

* One of the most remarkable and best known is that of hounds, in which the constant habit of cutting the tail has produced races in which this organ has naturally only the length which was artificially left in their progenitors.

stances which have formed them cease to act, and the old conditions under which they lived have returned, they recover more or less their first form. 3d, Races proceeding from a common stock, differ from each other only in characters of little importance and altogether superficial; that is to say, the exterior causes which determine races are incapable of altering the anatomical and essential characters.

All these facts are the result of numerous observations, and may be considered as demonstrated. They have too often been erroneously confounded with the less certain deductions we have made, and the direct results which may be drawn from them have been erroneously placed on the same footing as the hypothesis deemed necessary to complete the idea we seek to form of a species. It is principally with the view of drawing attention to the point where the solid basis of facts has been left for the shifting ground of hypothesis, that I have dwelt so long on this preliminary analysis.

The three principal characters of races being established, it has been admitted that beings not presenting them did not proceed from the same stock, and, deducing from this idea the definition of a species, such as spring from a common origin, and also differ from each other by more important characters than those which separate races, have been considered as beings of the same species. It is impossible not to perceive that, in this assertion, the direct results of the observation of facts has been extended by an hypothesis. It is, in reality, unquestionable that animals emanating from the same stock *may* form races, and even that beings not differing from each other but by their characters of race, have a common origin; but it is not on that account directly demonstrated that the descendants of a common stock *may not* differ by more important characters than those which actual science has established in the races now known; for we know only a small number of species modified in this manner, and in circumstances which, perhaps, are neither the only ones nor the most active. It is not, consequently, directly demonstrated that the beings which differ from each other by more important characters than those of the races *with which we are acquainted*, have necessarily a different origin. I may add, that for my own part I am much disposed to admit the strength of the arguments in favour of this hypothesis; but I think it necessary, for the distinctness of the discussion, to distinguish it from the facts formerly cited, which possess a degree of certainty that can scarcely be disputed.

Let us illustrate this by some examples drawn from the application of the three characters indicated above. It is proved, by extending the first character, that when two beings cannot, by their copulation, give birth to a descendant, or when this descendant itself is incapable of reproduction, they have not had a common origin. This assertion, considered as an axiom by many naturalists, is, however, merely a hypothesis which I think very likely to be true, but not indisputable. Thus the Arab horse and the Flemish horse may

give birth to descendants capable of reproducing themselves, and we consider them, probably with reason, as having had a common origin; while the horse and ass, which give birth to sterile mules, are regarded as proceeding from two stocks different in their origin. Now this is exactly what it is necessary to demonstrate; for what assurance have we that unknown circumstances, operating during an indefinite period, might not have sufficiently modified a primitive type, so as to induce the differences which distinguish the ass from the horse, and that these circumstances have so changed their respective natures, that their copulation is no longer attended with the same results as those which we observe between individuals less modified? We may further add, that everything relating to these crossings presents numerous anomalies. We thus find, particularly in warm countries, examples of fertile mules (of the ass and horse); and in the race of dogs, cross breeds are spoken of whose fecundity ceases after a certain number of generations.

The second character, that is, the tendency to return to the primitive type, presents us with numerous difficulties, for we cannot always distinguish the action of the external agents modifying a normal type, from that of the same agents destroying these anterior modifications. Thus, as we have said, Flemish horses taken to Arabia, acquire, after some generations, the forms of a horse of pure blood, while Arabian horses, placed among the moist pastures of Flanders, acquire heavy forms. Which of these two modifications is the alteration, and which is the return to the type? This is a point not easy to decide. It is true that there are many cases where no uncertainty exists; this, in particular, takes place in the study of the influence of domestication, and in that of reversion to the type by resuming a wild state.

With regard to the third character, consisting in this, that the action of exterior agents, operating on beings which proceed from a common stock, can affect only certain superficial characters, authors have been obliged, in order to render it available, to assign more precision to it than the strict observation of fact authorises. In some well-known species, the limits of the variations produced by climate, change of life, nourishment, &c., have been studied; and it has been thence concluded, that the extreme of the modifications obtained by these means, was the limit of the differences which can be produced among individuals of common origin. In this assertion, hypothesis has again exceeded what has been really demonstrated, for it would have been necessary to prove that there never were circumstances more active, and that we know all the effect which a very long duration of time could produce. I believe it is true, as I have said elsewhere (*Palæontology*, i., 86), that we must take care not to exaggerate the effect of these unknown causes, and that the study of actual agents is the true basis of our knowledge; but I cannot re-

fuse to acknowledge that we have here an hypothesis (very likely to be true) which admits of the qualification of being open to dispute.

It is by this combination of facts and hypotheses that we have succeeded in establishing that beings which have a common origin always preserve the traces of it, 1st, by their power of reproduction, and giving birth to fertile descendants; 2d, by their tendency to resume typical forms when they have lost them; 3d, by the identity of their essential characters. An assemblage of beings thence ascertained to have had a common origin, has been considered as constituting a species. In order to attain to this notion, we have been obliged to associate the union of these characters with the necessity of a common origin, and their absence with that of a different origin. This association has been made by means of a bond of connexion very likely to be true, and justifiable by sound arguments, but which, in strict logic, must be regarded as hypothetical and open to discussion.

But if a species, regarded in a theoretical manner, is not, in the present state of the science, capable of receiving a precise definition, and of being placed on an unquestionable footing, it is not less true, that, in practice, this word represents a very distinct idea. Without going back into the night of time, or pronouncing on the first origin of beings, we can, by confining ourselves to the study of actual phenomena, characterise a species in such a manner that almost all naturalists will be nearly agreed as to limits. Even such of them as are most at variance in their theoretical opinions on this difficult subject, are found, in general, to agree when they have occasion to name and describe the beings which now people the world; and they generally separate, as species, those beings which differ in more important characters than the modifications which external agents can effect in their organism *in the present day*. The practical distinction of species rests almost wholly on the intelligent study of these modifications.

If the analysis I have given be correct, we may deduce three consequences from it: 1st, That we do not always possess *certain* means of determining whether beings have had a common origin; 2d, That the limitation of actual species must remain independent of the opinion which may be adopted as to their first origin; 3d, That, in order to discover the law of specialty of fossils, we need not take the connexion of the idea of a species with that of a common origin as the point of departure, but, on the contrary, set out with the same principles as those which direct the study of existing nature. This is the only means of preserving the necessary strictness and precision in this discussion, for, unless we do so, we abandon a notion comprehended by every one, for an hypothesis which we have seen to be open to discussion and dispute.

This manner of adjusting the discussion on the specialty of fossils, which renders it independent of the opinion that may be entertained

on the mode in which the different faunas succeeded each other, may appear only to throw the question farther back. I indeed admit, that we thereby diminish its theoretical importance, and that we reject the discussion of hypotheses relative to the succession of animals in that of the theory of successive creations. But I think that, in a logical sense, it is necessary that a law, which ought to be merely a simple generalisation of facts, should rest solely on observation, and be free from all hypothetical conceptions; in other respects the law, such as we here understand it, still preserves sufficient importance, whether in a palæontological view, in which it establishes one of the most remarkable facts in the history of the globe, or in a geological point of view, for it is not necessary for the geologist to solve the question as to the origin of beings, but rather to determine whether the fossils studied by ordinary zoological methods all differ from one formation to another, and, consequently, that they may all serve to characterise formations, or whether a certain number of them only can be regarded as characteristic shells.

I admit, then, that the law of the specialty of fossils consists in this, *that each formation contains fossils which differ from all those of other formations, at least, that they differ from each other as much as the beings now existing in nature which we consider as different species.* Now, as I have stated above, I regard this fact as indisputable within certain limits, and that to deny it totally is to reject the most direct lessons of observation. No species (assigning to that word the value given above) is found at the same time in the formations of the primary epoch, and in those of the secondary, any more than in one of the latter, and also in the tertiary epoch. No species is common to the pennine, triassic, jurassic, or cretaceous formations. These important and essential facts, admitted by all geologists, and which form the basis of the science, are sufficient to establish the existence of this law.

But if it be indisputable when expressed in these general terms, it is also true that it is more difficult to fix its limits. MM. Agassiz, D'Orbigny, &c., and numerous palæontologists after their example, extend it to all the subdivisions of the crust of the earth known under the name of formations, such as the five or six jurassic stages, the five cretaceous stages, the three tertiary stages, &c. I believe, with them, that the more the science advances, the more will it confirm this method of regarding it; but a complete demonstration can only result from a more perfect science, and it is to the illustration of this essential point that the principal efforts of palæontologists ought to be directed. I have already shewn elsewhere (*Paleontology* i., 64), that a multitude of erroneous assimilations have been made, and I believe that the attacks upon this law are very often owing to the imperfect determination of fossils, or a bad classification of formations, whose limits have been sometimes misunderstood, and the subdivisions too greatly multiplied. In every case, and whatever may be the

opinion adopted as to its extension, this important law appears to me unquestionable in its general sense, and it cannot be seriously disputed if it be discussed on the foundation where I have placed it.

I now proceed to the discussion of the *theory of successive creations*, a discussion which the analysis I have made will greatly abridge and facilitate.

The law of the specialty of fossils being established, at least within the limits indicated above, and numerous observations having removed all doubt that different very strongly-marked types have characterised certain geological epochs, and are altogether wanting in the others, palæontologists have come to recognise the existence of a certain number of distinct faunas, and have endeavoured to explain their succession, that is, to give an account of the phenomena which must have occurred on the globe by leaving these numerous remains, so regularly associated, as the marks of their passage.

The question does not here relate to a simple generalisation of facts, but to hypotheses more or less probable, among which it remains for me to shew, that the theory of successive creations is the only one of all that have been proposed that is admissible, that in its general expression it agrees very well with facts, and that the objections brought against it bear, not on its existence, but rather on the degree of generality and extension which should be conceded to it.

If we examine all the opinions which have been brought forward with the view of explaining the cause which has associated fossils in the order we now see them, we find only three worthy of attention.

The first, that of *successive extinctions*, still supported of late years by a skilful anatomist, assumes that all animals have been created at once, and that they all lived together on the earth; but that various catastrophes (deluges, upheavals, changes of temperature, &c.) have successively caused a certain number of species disappear. Each of these destroyed species has, in consequence, left its remains in the formations made before its extinction, and the traces of it are wanting in posterior formations. According to this hypothesis, there have only been *successive extinctions*, such as those we can observe even in our own day, in regard to some species which have recently disappeared, or will soon do so, from our continents. This theory, attractive by its simplicity, is diametrically opposed to the entire amount of facts with which we are acquainted. Before it could be admitted, it would be necessary that we should find some existing species in the formations of the different epochs; it would be necessary that the bones of the mammifera of the eocene formations should be mingled with those of species now living—that along with the gigantic reptiles of the secondary epoch, we should find the present inhabitants of our seas—that the ganoïd fishes of the ancient formations should be associated with the cycloïdes and etenoides—that the silurian and devonian deposits should contain, along with

their characteristic fossils, the ammonites and belemnites of the jurassic seas, as well as the genera and species which we find only in the tertiary and modern formations ;—it would be necessary, in other words, that all the facts collected by palæontologists and geologists for forty years should be considered as null and void.

The second theory is that of the *transition of species* from one into another. It assumes that the animals of recent epochs have all descended, by direct generation, from the animals of the most ancient epochs, and that the prolonged modifying action of exterior agents, by perfecting or altering a long series of generations, is the only cause of the differences that exist between different faunas. This theory is founded on some facts which I have referred to above, and it sees, in the circumstances to which we have traced the power of forming *races*, forces sufficient to explain all the appearances of new types. Its advocates think that the same agents, whose present action is limited, and can produce only slight differences, may have exercised a more powerful influence when nature was younger, and in a state of things when the constitution of the surface of the globe was more variable than it is now. According to these naturalists, the different formations contain, in their fossil remains, only the traces of the state at which organism had arrived at the time when they were deposited.

I shall not here enter into the detailed discussion of a theory which I have already so often combated ; I shall merely state, that the very slight modifications produced in our own day in species by the prolonged influence of exterior agents, never exceeding the superficial characters, are just a proof of the insufficiency of the variations of these agents to alter essential characters. It is particularly to be remarked, that the object is not to explain modifications of little importance, but the existence, at all periods, of numerous types altogether peculiar ; and that, in order to apply the theory in question, it would be necessary to admit that reptiles of the secondary epoch have had their ascendants in the fishes of the primary epoch, and their descendants in the reptiles, and perhaps in the mammifera, of our own epoch. We ought, in such a case, to seek the origin of the cycloid and ctenoid fishes of our seas, in the ganoids of the secondary epoch, and the forefathers of the latter in the anomalous fishes of the primary epoch. We ought to admit that the diverse types of mammifera are only transformations, by way of generation, from the more imperfect animals which have preceded them, and that elephants, rhinoceroses, &c., are the direct descendants of the pachyderms of the eocene period. It would, finally, be necessary that man should look for his forefathers among some of the superior types of the animal kingdom. Where are facts to be found which justify such bold and extravagant fancies ? Are they not opposed to all that observation teaches us ?

There remains, then, the third theory, that of *successive creations* ;

but, before defending it, it is necessary to attend to a few preliminary considerations.

In the first place, this theory, which has some times, by a more vague, but probably on that very account a more apt designation, been called the *theory of successive appearances*, ought to be defined in a very extended sense. It consists in admitting that at certain epochs new beings have appeared on the surface of the earth, without having the tie of a direct generation with those that went before them. The ordinary laws which we recognise in nature as now existing, have not been sufficient to account for these appearances, and the regular series of generations is found to be replaced by other facts. In the scientific discussion of this theory, it ought not to be complicated by considerations of another order; besides, it is probable that the human mind would seek in vain to account for what has taken place at these different epochs, and that it can no more comprehend these successive creations, than it can comprehend the first. It is impossible and fruitless to seek to answer the question, whether, in these great events, the Creator has produced each being by a direct and special intervention, or by the action of unknown laws manifesting themselves perhaps at certain intervals in a regular and uniform manner.

I may remark, in the second place, that the theory of successive creations or appearances has degrees, and may be understood in a more or less extended manner. Some admit it in regard to *all* the beings of the same geological epoch, and consequently connect it in an intimate and necessary manner with the law of the specialty of fossils. Others admit it only in the case of well-marked types, and which have no *analogues* in the period which has preceded them. It is convenient to discuss it first in the second sense, that is to say, in its most restricted acceptation.

Now when put in this manner, this theory appears to me almost beyond dispute. If we admit, for example, that elephants have lived on the earth only since the middle of the tertiary epoch, and if we do not choose to regard them as descendants of the *palæotherium*, or some other type of the eocene epoch, we must consider their existence as presenting something instantaneous and without direct connection with what preceded it. If we are unwilling to believe that man proceeds from some mammifer by way of direct generation, and at the same time admit that he appeared after the inferior types, in vain shall we struggle against this theory, or seek for another explanation in the present state of the science. We shall find thousands of examples equally evident.

It remains for us to shew how far this theory may be extended. Ought we to admit that at the end of each geological era *all* the animals have been destroyed, and that at the commencement of the following era an entire fauna has always been created? This is a

more difficult question, and open to controversy. Let it be always observed, that if we admit the theory of successive creations for the well-marked types, the extension of this idea to all the beings of an epoch no longer presents so great a difficulty to the imagination, and that the principal theoretical objections which may be made are easily refuted, if we allow the necessity of admitting a *certain number* of successive creations. Let it be remarked, in the second place, that this theory applied to all beings, forms with the law of the specialty of fossils a logical whole, and gives an indisputable weight to the arguments which support both the one and the other. At the same time there are facts opposed to this extension which must not be overlooked.

I have remarked on another occasion (Paleontology i., 91), that the theory of successive and complete creations, accounts well for the differences which exist between the different faunas, but it explains ill the striking resemblances we often find between two successive faunas. If, for example, we compare the Turonien and Albien* faunas, in which the greater part of the species are very similar in form, although really distinct, is it probable, that all the Albien species have been destroyed, and then replaced in the Turonien epoch by a number of nearly equal species, each of which has analogues in the Albien epoch? Have these species any direct bond of connection between them? This appears to me a point on which little light has yet been thrown. The same thing may be said on comparing the different jurassic faunas, the devonian and carboniferous faunas, the different tertiary stages, &c. Perhaps we ought to admit successive creations only in respect to the types which are without analogues in the preceding fauna, and allow to the theory of the transition of species some influence in explaining the analogies of successive faunas. The decision of these questions belongs to the future state of the science, and the numerous facts which palæontologists are every day collecting, the exact description of fossils, local geological faunas, &c., are the necessary bases which will enable future enquirers to solve them.

I shall conclude by remarking, that every time I have appealed to facts in support of my views on this subject, I have spoken of facts actually known, and am ready frankly to admit the authority of new facts, even when they are opposed to my deductions. Such a discovery may be made as shall change the face of a science still in its infancy, and not firmly established. The bones of man, of the elephant, or lion, once found in the ancient formations, would overthrow all this scaffolding, and force us, *volens volens*, to reconstruct the entire edifice. But I am fully confident that these facts will never present themselves, and the signal and daily confirmation which observations, made in all parts of the globe, bring to the laws of

* The Albien or gault and the Turonien belong to the chalk system.

palæontology, leads me to believe that we are following the proper direction, and if all do not yet go with us, the number of those who deviate will diminish every day.—(*From Supplement à la Bibliothèque Univer. de Genève*, No. xxi., page 23.)

The Migration of the Ancient Mexicans, and their Analogy to the existing Indian Tribes of Northern Mexico. By GEORGE FREDERIC RUXTON, Esq., F.E.S.* Communicated by the Ethnological Society.

Where no other data than the vague apocryphal legends and rude hieroglyphics of a semibarbarous people reward the researches into a nation's history, it is almost impossible to derive even a probable hypothesis as to its origin, or to trace even, by such uncertain evidence, the different phases which it may have exhibited, in its progress from utter barbarism to comparative civilisation.

Perhaps in no case is this fact more truly exemplified than in the history of the people which are the subject of the present sketch; and, although a more than ordinary amount of talent, diligence, and assiduity have been devoted to bring to light and unravel the mass of confusion which native traditions and hieroglyphics present to the historians of the Mexicans, yet, nothing are we permitted to receive as fact, or to affirm as warrantable evidence of any portion of Mexican history, but the oral traditions handed down to us by the earliest writers of the Spanish conquest; refusing altogether such uncertain data as the rude picture-writing, interpreted by every one in a different manner, which serves more to confuse than throw a light on the interesting subject.

What, therefore, may be asserted with the semblance of truth is simply this, that the portion of Mexico, classically known as the Valley of Anahuac, has been peopled by at least nine distinct tribes, who succeeded each other in that comparatively circumscribed tract, the first of these being the Toltecs, and the last (who held it at the time of the conquest by the Spaniards) the Aztecs.

It is probable that, although distinct *tribes*, they belonged

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to one and the same great *nation*. The Toltecs and the Aztecs (who were the first and last of the migrate tribes) possessed a similar and nearly equal amount of civilisation, which must have been the source from whence it spread into Southern Mexico.

Of these tribes, it is only necessary to speak of the two above mentioned, since of none of the intermediate ones is there any information but of the most vague and uncertain character; and at the same time it must be borne in mind, that no part of Mexican history can be adduced as probable fact, but that the valley of Anahuac has been peopled by different tribes, whose successive occupancy of the country extended over a space of about 800 years, and of whom, it is repeated, the first were the Toltecs, and the last the Aztecs, or Mexicans of the Conquest.

Cotemporary with these, the wild and wholly barbarous people, called Ottomies, hovered on the extreme boundaries of the civilised states, refusing to benefit by the example of the immigrated tribes, and for the most part engaged in constant warfare with them, to recover the lands of which they had been despoiled.

The Ottomies, then, were probably the aborigines of Anahuac, and a certain analogy may be traced in their character and habits, to the savage tribe of Apaches, who infest the Northern States of Mexico at the present time.

It is certain that the Toltecs, as also the Aztecs, came from the north, and, according to the traditions of the people, the Toltecs brought with them a high degree of civilisation, higher than that possessed by the Aztecs; but that the ancient Mexicans had attained to any other than the most primitive stage, is not borne out or warranted by *any remains* which are left in these days to direct our judgment.

The Aztecs are supposed to have inhabited a country north-east of the Gulf of California, called by them Azatland; but its exact locality is entirely suppositious. Somewhere about the year 1160 of our era, they commenced their migration to the south, and the cause of this movement is equally involved in obscurity.

During this migration they are supposed to have made three great halts, the first of which was on the Gila, a stream which, after joining the Rio Colorado, runs into the Gulf of California. Here they remained a considerable period, building a city, the remains of which are to be seen covering a large space; the walls of buildings and acequias, or irrigating canals of great depth, are still visible; and immense quantities of broken pottery strew the ground.

The ruins of two other cities, south of the Gila, are assigned as other halting-places during their migration; and these remains are identical with those on the above named river. From the great extent of the foundations of these structures, and parts of walls which are still standing, and which shew that the buildings must have been of extraordinary size, these remains have been always termed the Casas Grandes, or Great Houses. Now, northward of the Gila, in the province of New Mexico, and over a vast extent of country, extending from the Rio Grande to the main chain of the Cordillera, are found, at the present moment, many tribes of Indians, who build and inhabit towns and houses of the same form as the Casas Grandes of the ancient Mexicans. Those dwelling in the valley of the Rio Grande are called *Pueblo* Indians, from the fact of their dwelling in towns, whilst beyond the civilised settlements to the north-west, is a tract of country inhabited by the Moquis, of whom but little is known; but who are reported to enjoy a comparatively high state of civilisation,—that is, compared to the barbarism of the hunting-tribes.

It, therefore, appears highly probable that, from this region the ancient Mexicans first emigrated; and it may be inferred that they sprang originally from the Indians now known as Pueblos, or that the latter are a branch of the Aztecs, which remained behind at the time of their first great halt. At all events, we must look to the country north of the Gila, extending to the Great Salt Lake, and bounded on the westward by the Pacific, and eastward by the Rocky Mountains, as the locality from whence the Aztecs migrated to the south; for, to the northward of this tract, the salitrose de-

serts round the Great Salt Lake, and the barren and inclement regions to the north of these again, present a natural obstacle to the supposition, that they could come from remoter regions than the one assigned.

It is generally supposed that no traces of the Aztecs exist northward of the river Gila ; but, in the country of the Navajos, as well as in that of the independent Moquis, are still discoverable traces of their former habitations ; and, as I have before remarked, the Pueblo Indians, as far north as the valley of Taos, construct and inhabit villages and houses of the same form as the Casas Grandes of the Aztecs, retaining many of their customs and domestic arts, as they have been handed down to us, and many traces of a common origin.

In the absence of any evidence, traditionary or otherwise, on which to found an hypothesis as to the probable cause of the migration of the Mexicans from the north, I have surmised that it is possible that they may have abandoned that region on account of the violent volcanic convulsions, which, from the testimony of persons who have visited these regions, I have no doubt have, at a comparatively recent period, agitated that portion of the country ; and from my own observation, the volcanic formations become gradually more recent as they advance to the north, along the whole table-land, from the valley of Mexico to Sante Fé in New Mexico. These disturbances may have led to their frequent changes of residence, and ultimate arrival in the south.

If their object was to fly from such constantly-recurring commotions, their course would naturally be to the south, where they might expect a genial soil and climate, in a direction in which they might avoid the numerous and warlike tribes who inhabited the regions south of their abandoned country. Thus, we find the remains of the towns built, in the course of their migration, in insulated spots of fertility, oases in the vast and barren tracts they were obliged to traverse, which spread from the shores of the Great Salt Lake of the north towards the valley of the Gila, and still southward, along the ridges of the Cordillera, which stretch far away to the southern portion of the country.

And here I may remark, that this inference is borne out by the fact, that the sites of their ruined towns present, at the present time, some of the most barren and unproductive spots to be found in northern Mexico, and nearly all are situated in volcanic districts, which have every appearance of having been disturbed at a comparatively recent period.

Having thus slightly drawn attention to the ancient inhabitants of Anahuac, and the probable locality from whence they emigrated to that country, we will see how far we are justified in affirming that the Pueblo Indians and the ancient Mexicans are descended from one and the same stock. Francisco Vasquez Coronado, who was one of the early explorers of New Mexico, asserts that, in the vicinity of a river which was called "Tegue," there dwelt a nation who built houses three stories high, and who spoke the same language as that used by the Aztecs of the valley of Anahuac. In some old MSS. lately discovered in New Mexico, this people were supposed to form a kingdom called "Sivolo," to which frequent reference is made as being the seat of considerable civilisation when compared with that of other tribes through whom the travellers had passed on their way to the distant north. Fray Ruiz, and Venabides, both Franciscan monks, preached to thousands of Indians who came from the direction of this kingdom of Sivolo, and were astonished at their docility, and the "extraordinary cultivation of their intellects." As they do not mention to have met with any difficulty in holding communication with this people, and as they preached daily to them without interruption, it may be taken for granted that the language spoken was intelligible to both; and as most of the Missionary monks were conversant with the Mexican dialect, it must have been through that channel alone that they communicated with the native tribes of this remote region.

These Indians, like the Pueblos of the present day, preferred to build their towns and villages on the summits of almost inaccessible cliffs, the approach being by means of a zig-zag path cut out of the precipitous sides. The bluffs, or mounds of volcanic formation, called *mesas* by the Mexicans, on account of

their tabular form, were invariably selected if in a fertile locality. The entire country from the valley of Mexico to that of Taos, a distance of 2000 miles, being more or less of volcanic formation, presents many of these favourite mounds, which sometimes rise isolated in the centre of extensive plains, and of extraordinary regularity of outline, having the appearance of gigantic tables. Others are of pyramidal form, and these the ancient Mexicans made use of as bases or pedestals for their *teocalli* or temples, sometimes facing them, or pointing the corners, with solid masonry. These tabular hills have been ingeniously described, by writers on Mexican history, as artificial structures, rivalling, in grandeur of design, and the industry and labour necessary to their construction, those monuments of art and human industry, the pyramids of Egypt.

It is generally affirmed that the Aztecs were not originally an agricultural people. That this is an error, any one who has visited the ruins of their ancient towns on the Gila, and in other parts of Northern Mexico, can testify beyond a doubt. The remains of ditches and canals, by which the corn fields were irrigated, are plainly perceptible, and the fields themselves can, in many parts, be distinctly traced. In the northern portions of Mexico, this is rendered easy of detection on account of the absence of timber or brushwood, and the consequent bareness of the soil. In the south, where the ground is covered by heavy timber, or a dense vegetation, nothing but the solid blocks of masonry used in the construction of their dwellings are visible to the eye, and any traces of agriculture are concealed by the impenetrable jungle which covers the country.

The Indians of Northern Mexico, including the Pueblos, appear to belong to the same great family—the Apache, from which branch the Navajos, Apaches, Coyoteros or Wolf-Eaters, Mescaleros, Moquis, Yubissias, Maricopas, Chiricacuis, Chemeguabas, Yumayas (the last two, tribes of the Moqui), and the Nijoras, a small tribe on the Gila. All these speak dialects of the same language, more or less approximating to the Apache, and of all of which the idiomatic structure is the same. What relation this language bears to the

Mexican has not been satisfactorily ascertained ; but my impression is, that it will be found to assimilate greatly, if not to be identical.

The Pueblo Indians of Tāos, Pecūris, and Acōma, are supposed to speak the original language, of which the tribes lower down the Rio Grande, including the Pueblos of San Felípe, Sandía, Yslēta, and Xeméz speak a dialect.

These Indians are eminently distinguished from the New Mexicans, or descendants of the Spanish conquerors, in their social and moral character, being industrious, sober, and honest, the women being as remarkable for chastity as the New Mexicans are notorious for the laxity of their morals ; indeed, a universal concubinage exists amongst the latter, the example of incontinence being set them by the priests, who in these remote regions are under no supervision of Church authority.

Although most of the Pueblo Indians are nominally Christians, and have embraced the outward forms of the Roman Catholic Church, they still cling to the belief of their fathers, and celebrate in secret the ancient rites of their own religion. The aged and devout of both sexes may still be often seen on their flat house-tops, with their faces turned to the rising sun, and their gaze fixed in that direction, from whence they expect, sooner or later, the god of air will make his appearance.

Amongst many of the religious forms still retained by these people, perhaps the most interesting is the perpetuation of the holy fire, by the side of which these Indians, as did the Aztecs, keep a continual watch for the return to earth of Quetzalcoatl', the god of air, who, according to their traditions, visited the earth, and instructed the inhabitants in agriculture and other useful arts. During his sojourn, he caused the earth to yield tenfold productions, without the necessity of human labour ; everywhere corn, fruit, and flowers delighted the eye ; the cotton plant produced its woof already dyed by nature with various hues ; aromatic odours pervaded the air ; and on all sides resounded the melodious notes of singing birds. The lazy Mexican naturally looks back to this period as the " golden age ;" and as this popular and be-

nificent deity, on his departure from earth, promised faithfully to return and revisit the people he loved so well, this event is confidently expected to the present day.

Quetzalcoatl' embarked in his boat of rattlesnake-skins on the Gulf of Mexico, and as he was seen to steer to the eastward, his arrival is consequently looked for from that quarter; and when the Spaniards arrived from the east, as they resembled the god in the colour of their skin, they were generally supposed to be messengers from, or descendants of, the god of air.

This tradition is common to the nations of the far north, and in New Mexico the belief is still clung to by the Pueblo Indians, who have for centuries continued their patient vigils by the undying fire. Its dim light may still be seen by the wandering hunter, glimmering from the deep recesses of a cave in the mountains, when, led by the chase, he passes in the vicinity of this humble and lonely temple.

Such a striking analogy as that described above almost proves the connection of the two people, and this prominent similarity, nay, identity of religious rite, is at all events sufficient evidence to warrant the inference I have drawn, as to the community of origin of the Pueblo Indians and ancient Mexicans.

From what part of the Old World, or whencesoever these people passed, from Asia or Africa, into the continent of America will not be touched upon here; neither is it necessary to adduce any of the arguments which have been brought forward to prove the fact of the Mexicans having sprung from Asiatic origin. Such arguments, based upon alleged analogy of customs and religious rites, having, in the opinion of the writer, but little weight or reason attached to them; for is it not natural that the expression of that instinctive religious feeling, which exists in the breasts of even the most barbarous of mankind, should find a vent in rites and ceremonies which, however primitive, may yet bear some analogy to those practised by civilised people? The adoration of a Supreme Being, whether invested with the beautiful attributes of the Christian's Deity, or the grotesque or horrible power with which the idolatrous savage clothes his god, may yet take the

outward form of ceremonies which bear resemblance to each other.

The mind of the savage, however rude and uncultivated, seeks to account for natural phenomena by properly attributing to a Superior and Omnipotent Being the work his senses assure him could not be effected by mortal hands.

Feeling towards this mysterious power either most abject dread or unlimited adoration and love, he worships him in the form which, according to his notions, will be most agreeable to the Deity ; and whether in the costly sacrifices of the ancient Mosaic creed, the ostentatious forms of Christian worship, or in the humble votive offering of the primitive savage, who blows to the Great Spirit the (to him) costly offering of the first exhalation of the fragrant tobacco, the spirit of the rite is still the same.

But who would argue from this that the Choctaw, who offers the first puff of his kinnik-kinnik as a sacrifice to the "Great Spirit," is descended from the followers of Moses, who rendered up the costly burnt-offerings of their rams and goats, and oxen.

The holy fathers, however, who first visited Mexico, went beyond this, and recognised in certain rites of Indian idolatry, an analogy to the sacraments of baptism and the holy Eucharist. The cross, the sacred emblem of their faith, was also beheld, according to these devout men (who were so strong in faith as to see what otherwise was denied to common sight), raised in the heathen temples of the Aztec, and worshipped with as much zeal as in the churches of their own land ; such crosses having, in fact, been erected by the early Spanish conquerors, who left in their path the holy emblem, as an authority and warrant for the deeds of bloodshed and rapine which everywhere marked their progress on the soil of Mexico.

Indeed the accounts of the Monkish historians of the Conquest, as well as of the other Spaniards who have written upon Mexican history, if not entirely fabulous, must yet be received with caution and distrust, and in no case reliable as authority. The Pueblo Indians, who are the original inhabitants of New Mexico, are the most industrious portion of

the population, and cultivate the soil in a higher degree than the civilized descendants of the Spaniards themselves. They number about 12,000, without including the Moquis, who have preserved their independence since the year 1680.

Their houses are constructed in a most singular manner, being of two, three, and even five stories, without doors, or other external communication than by a trap-door in the azotea or flat roof, which is reached by means of ladders. One wall surrounds the different dwellings, and the entire village is contained in one of these buildings, and under one roof.

Of similar construction appear to have been the houses on the Gila and elsewhere, which are supposed to have been built by the ancient Mexicans in their migrations to the south.

In physical conformation, these Indians vary but in a slight degree from the Prairie tribes, being perhaps a little more inclined to corpulency, with the muscles of the arms and legs more strongly developed, owing to the severer labour which the former are engaged in. Indeed the physical organisation of the Indians, from the lakes of the north to Patagonia, differs so little as to exhibit but a modification of physical feature, apparently caused by climate and localisation.

The dress of the Pueblos is a mixture of the ancient costume with that introduced by the Spaniards. A tilma, or small blanket coat, without sleeves, is worn over the shoulder, and their legs and feet are protected by leggings and mocassins of deerskin or woollen stuff.

Their heads are uncovered, and their hair long and unconfined, save the centre or chivalrous scalp lock, which is usually bound with gay coloured ribbon.

The women's dress is the same as that of the wild Indians of the Prairies, being a robe of finely-dressed doeskin, generally covered with a bright-coloured blanket, or mantle of cloth.

It has been said before that the Pueblo Indians refuse to celebrate their ancient religious ceremonies in the presence of strangers, and that ostensibly they conform to the Roman Catholic Church. It is not, however, the less certain that

this seeming abjuration of the idolatry of their fathers, is alone for the purpose of conciliating their conquerors, and in order that no hindrance or molestation should be offered to the observances of their secret faith.

Like the Aztecs, they have their high priests, so called at least by the exaggerating writers of the Spanish Conquest, but which functionaries would be better known to all conversant with the American Indian, as "medicine or mystery men;" the "Obi" of the African negro.

Indeed if all the erudite historians, who have so elaborately worked up into the most interesting romance the meagre materials afforded by Mexican history, had so simplified their work as to write only that which they conscientiously believe to be true, or in other words, had called things by their proper names, instead of being puzzled and mystified at the strange anomaly of civilisation and barbarism exhibited by the ancient Mexicans; if they had been described to be what in truth they were, and no more, a tribe of Indians dwelling in lodges of stone, and living by agriculture, we should be the better able to appreciate their real state, and to draw a comparison between the pomp and glory of the Court of Montezuma, emperor of the Mexicans, and the same regal splendour displayed at the present time in the Medicine Lodge of Tum-ga-cosh or Buffalo Belly, the chief of the mighty nation of the Comanche.

Fray Augustin Ruiz and Venabides visited New Mexico as early as the close of the sixteenth century (about the year 1585), and they declare that upwards of a million of Indians sought baptism at their hands, impelled by the commands they had received from a white woman, who had for many years been preaching amongst them. It seems that on a rosary being presented to some of these Indians, on which was a medallion bearing the effigy of some female saint, they immediately recognised the robes in which she was represented, as being of the same form and colour as those worn by the female who had instructed them, and who made her appearance from the direction of the Moquis country.

It is singular that the Moquis are called by the American trappers and hunters, who visit their country in the course of

their adventurous expeditions, the "Welsh Indians." It is a common belief in the United States, that the first discoverers of North America were Prince Madoc and his Welsh followers, and that their descendants still exist in some unexplored part of the continent. The hunters and trappers found their supposition on this fact, that the Moquis are much fairer than the other Indians, and have many individuals among them who are perfectly white, with light-coloured hair and eyes, which is accounted for by the frequent occurrence amongst the Navajos, and probably the Moquis of Albinos, with the Indian features, but light complexions, eyes, and hair.

In connection with this, I may mention a very curious circumstance which happened to me, and which tends to shew that there is some little foundation for the belief of the trappers, that the Moqui Indians are descendants of the Welsh Prince and his followers.

I happened, very recently, at Fort Leavenworth, on the United States frontier, to enter the log-hut of an old Negro woman, being at the time in an Indian dress, over which was thrown a Moqui or Navajo blanket. The old dame's attention was called to it by its varied and bright colours; and, after examining its texture carefully, she suddenly exclaimed, "That's a Welsh blanket, I know it by the woof." She had, she told me, in her youth lived many years in a Welsh family, and in a Welsh settlement in Virginia, or one of the southern states, and had learned their method of working, which was the same as that displayed in my blanket. The blankets and tilmas manufactured by the Navajos, Moquis, and the Pueblos, are of excellent quality, and dyed in durable and bright colours; the warp is cotton, filled with wool, the texture close and impervious to rain. Their pottery is the same as that manufactured by the ancient Mexicans, painted in bright patterns, by coloured earths and the juice of several plants. In the country of the Moquis are the remains of five cities, on the sites of which they still inhabit the villages, said to be the same in form as those constructed by the Pueblos. The names of four of these are Orayxa, Masanais,

Jongopai, and Gualpi. The fifth is doubtful. Some of the villages of the Pueblo Indians are very curiously located on the summits of almost inaccessible cliffs; Acomá and another, now in ruins, near the Pueblo of San Felipe, are thus situated; but the most extraordinary building is that of the Pueblo of Tãos, on the northern side of the valley of that name. It is built on a small stream, which divides the building into two equal portions, and is composed of seven stories, decreasing in breadth as they ascend, so that the vast hill has a pyramidal or telescopic appearance. The foundation covers an extent of 370 feet in length, by 150 in width, divided into several compartments, two rooms forming, as it were, the thickness of the walls, the outer of which, in each story, is generally inhabited, the other being used as a granary. A small window lights the apartment, to which the only communication is by a ladder through a trap-door in the roof.

In the centre of the building, on the ground-floor, is a large council-hall, where, under the presidency of their cacique or chief, they meet to transact the municipal affairs of the tribe, and where, more than once, plots have been hatched and matured, which have subverted the government of the incapable Mexicans.

In the numerous insurrections, raised and conducted by the Pueblo Indians, they have invariably considered it the best stroke of policy to strike at once at the very head of the obnoxious government; and, in nearly every instance, have carried out their plans by massacring the governor of the province.

But the other day, they rose against the Americans, who had taken possession of New Mexico, without opposition, and surprising the governor (a gentleman named Bent), whilst in the village of Fernandez, a few miles from the Pueblo of Tãos, murdered him in the most savage manner.

A few days after this, the American troops attacked the Pueblos, and after killing several hundred of its Indian defenders, levelled it to the ground.

It has been said that the singular perpetuation of a holy fire by which the ancient Mexicans watched for the return

of the god Quetzalcoatl' is also observed by the Pueblos. This rite was originally confined to one tribe and one locality, to which the devout of the different nations, even from the distant regions of the Moquis, are reported to have bent their steps in pilgrimage. This favoured tribe and "holy city" was that of "Pecos," situated on the stream of that name, about thirty or forty miles from the present Santa Fé.

Here, in a deep and obscure vault, the sacred fire was watched, and carefully tended by a class of Indians who were consecrated to the task, and here for ages it smouldered in a brazier of stone; the same fire which the Mexicans affirmed had been kindled from a spark struck by the hand of Quetzalcoatl' himself, during his memorable sojourn on the earth, and which, with patient care and devout vigils, the Indian hopes to keep alive until his return.

A few years since, the tribe became extinct, and the "Pueblos" of Pecos being abandoned, the sacred fire was carefully removed by the neighbouring Indians, and concealed in a secret cave in the mountains, where it is now preserved.

A curious feature in the internal government of the Pueblo communities is a system of police, for the purpose of preserving domestic tranquillity, and especially charged to guard against and punish acts of immorality on the part of the younger of both sexes. When the act of intercourse is proved before the head chief, the delinquents are immediately compelled to marry, and if adultery be added, the penalty is corporeal punishment, and, if an aggravated case, expulsion from the tribe. Unlike all other Indian tribes, professed prostitutes are unknown amongst the Pueblos, which fact is the more to their credit, with the demoralising example of their civilised neighbours ever before their eyes; indeed so proverbial is the chastity of the Pueblo women, that the New Mexicans, when they wish to describe one of their own countrywomen as being correct in her morals, say, "*Es Puebla*," she is a Pueblo girl, or she is an Indian in virtue.

They are celebrated for hospitality, and as faithful friends as they are bitter and implacable enemies ; but, surrounded as they are by a vitiated and but semicivilised people, oppressed for three centuries by grasping and tyrannical government, and existing in a country to which nature has accorded but few advantages, either of soil or climate, we see in the primitive and barbarous character of the Pueblo Indians of New Mexico much more to admire *than to condemn*.

Account of an Extensive Mud-Slide in the Island of Malta.

By A. MILWARD, Esq. (With a Plate.) Communicated by the Author.

Recent researches upon the phenomena of glaciers have shewn the existence of certain analogies between the motion and other characteristics of those bodies and those of viscous fluids. Various experiments were made to ascertain the peculiarities of motion of such fluids, more particularly with reference to internal structure, and its manner of formation ; and, by the use of different coloured layers of viscous matter, that structure has been shewn to bear a remarkable resemblance to the ribbon structure of glaciers.

The phenomena attendant upon the motion of viscous fluids became thus, as it were, a part of the subject ; and any particular example, besides its own individual interest, derives additional importance from the light which it throws on a new and beautiful investigation.

The writer is not aware of any recorded example of the motion of viscous fluids on a large scale : Experiments can only be carried out on a small scale. Under this impression, he considered that a detailed account of an extensive mud-slide which came under his notice in the Island of Malta might be worthy of notice. The occurrence of another mud-slide, on a small scale, has suggested an explanation of some of the phenomena of the first.

It is the object of the present paper to describe—

1st, The nature and appearance of the principal mud-slide.

2dly, To illustrate, from a comparison of the two examples some of the peculiarities of the first, and their analogy to the phenomena of glaciers.

1. Previously to the autumn of 1846, a large quantity of mud, dredged up from the head of the Great Harbour of Valetta, had been deposited on some nearly-level ground, beneath a line of low cliff which originally bounded that part of the harbour, and in the immediate vicinity of a large tank. The mud is of an alluvial character, containing shells and some small stones. From certain indications it would seem, that the mud—either from being so placed originally, or from previous motion—covered nearly the same extent of ground (that is to say about two acres) which it does at present. The slide that I am describing consisted in the flow of the main body of the mud, which was piled up on the right towards the sea, over the lower parts on the left. The autumnal rains appear to have thoroughly soaked this mud, previously dry and hard; and, the tank being full, the superfluous water which was turned off descended over the cliff, and increased the semiliquid state of the deposit.*

The result appears to have been, that the upper parts of the mud collected in a large heap near the sea descended gradually on the land side, and in some places passed beyond the original boundary. Six distinct streams, of different sizes, seem to have descended in this manner from the same origin. Their separation appears to have been caused by the difference of resistance and level in the surface of the dry mud over which they flowed. In several places the dark dry mud of the original surface may be seen separating the streams, and may be distinguished on the drawing by its deeper colour. From the elevation of the new streams, these old portions now appear as troughs of irregular form and surface, and are somewhat drawn and contorted by the motion of the streams on either side. In some cases the old

* So great was the pressure at one place, not included in the drawing, that the adjacent road and wall were pushed fifteen feet into the sea, to the great annoyance of the Government Surveyor, who seems to have had no notion of the locomotive properties of mud.

part is covered, and the adjacent streams press against each other.

These six streams may be considered as nearly independent of one another; their surface is an inclined plane, varying in its inclination at different points. The part where the flow commenced is usually the steepest; but in one instance (No. 5) this is not the case; the slope is there nearly the same throughout. Five out of the six streams present the singular appearance of curved bands, distinguished by being alternately dark and light in colour. These are best seen from a height when the sun is shining brightly upon the mud, and especially if the light fall obliquely. Upon examination, it is found that these curved bands are made apparent by the fact of their being composed alternately of rough and smooth mud. The smooth mud reflects the light more readily than the other, and thus appears of a lighter colour.

The rough bands are slightly the highest in the example before us, and are most broken up with cracks and crevasses. It will be observed that one of the streams (No. 5) is free from these bands: In the others their breadth varies from about three to six feet. The cracks or crevasses, with which the surface is broken up, are of course very irregular; but I think they may be classed under two heads, viz., those which are at right angles to the direction of the curves, and those which *follow* that direction. This remark applies to both the rough and smooth parts, but in the latter there is less confusion, and the crevasses are much further apart. In some places the one class of fissures prevails the most, while in some the other class predominates. Fissures of the first sort are seen prevailing in No. 3; those of the second class in No. 5. At the lower extremity of each flow, the mud is much more broken up than elsewhere; and when the concentric bands become indistinct, the cracks or crevasses are chiefly in that direction. When the mud has been very wet, and the flow steep, it is sometimes broken up by cracks into much more minute divisions; but this is not always the case, and was observed by me when the wetness seemed confined principally to the surface. Sometimes when the de-

scent is not particularly steep, mud which has been very wet will be found the smoothest and least cracked.

The curved bands appear to be most completely developed in an intermediate interval between the origin and the termination, and also to be widest at that part. An increase in the inclination of the stream appears to break up the curved bands and cause them to become confused, and separated into narrower bands, as at *d*, No. 3, in the drawing.

I regret that it was not in my power to procure transverse and longitudinal sections of any of the streams, so as to show the internal structure, and determine whether the distinction of rough and smooth bands obtains to any extent *below the surface*.

2. It is proposed, in the second place, from a comparison of the example which has just been described with another mud-slide, to illustrate the peculiarities observable in the drawing, and their analogy to the phenomena of glaciers.

The first and main peculiarity which I would observe is the existence of curved bands of rough and smooth mud alternating.

In the spring of the present year, I had an opportunity of examining another mud-slide, also on the borders of the Great Harbour of Valetta, but of smaller size, and in a different stage of development. In this case the moisture must have been derived almost exclusively from the rain, and not as in the other instance, from the auxiliary overflow of a tank. In the *first slide* the surface of the mud formed a continuous slope, and was not raised in ridges; the rough bands were very slightly higher than the smooth ones. In the *second case* there were the same bands of rough and smooth mud (much less defined, it is true, but still apparent), but *here* the rough bands were raised a foot and a half or two feet, so as to form ridges, waves, or wrinkles, swelling and falling over. This evidently resulted from the manner in which the mud had flowed, and the experiments which have been made upon viscous fluids seem to shew the occurrence of similar wrinkles, except that they are less regular and distinct. I do not, however, pretend to explain how

these wrinkles are formed, or what law they follow. Variation of consistency in the mud, arising from atmospheric changes, or other causes, may be supposed to have some effect; but the evident approximation to a certain regularity in the alternations of bands, would seem to point to some more *regular* agency.

If we may judge from the absence of bands in No. 5 on the drawing, which is distinguished from the other streams by having no *steep* flow at the commencement, the steepness of the first descent may be connected with the phenomenon. However this may be, the occurrence of these ridges in the second example is a fact, and they have every appearance of being a general phenomenon, not dependent on *local* peculiarities of resistance or obstruction.

Upon examination of the second example, it appeared clear to me, that the smooth mud owed its finer quality in a great degree, if not wholly, to the *drainage water* from the ridges above, holding in suspension the finer particles. The water naturally deposits this fine matter on the less-inclined intervals; and thus the intervals between the ridges become smooth at the expense of the latter, which are left comparatively rough.

I am of opinion that in the first slide the extreme saturation of the mud, arising from accidental circumstances, allowed the surface to subside into a slope, so as to conceal the mode of formation.

It is not at all impossible, that a subsidence may take place in the second mud-slide also; for on thrusting my stick through the upper crust, which had been dry for some two months, I found on withdrawing it, that the water dripped from its extremity. It cannot be expected to subside *entirely*, as it never could have been so wet as the mud of the first slide.

2. The second peculiarity which I have to remark is the appearance represented at *d* on the drawing, in the stream numbered 3. The curved bands are here seen to be broken up on account of the steepness of the descent; and yet below, when the angle of elevation diminishes, they reappear

even more distinctly than before. The same fact is observable in the ribbon-structure and dirt-bands of glaciers.

3. The third peculiarity which I would mention is the effect of obstruction very distinctly manifested in the same stream, No. 3.

The liquid mud appears to have pressed against the old and comparatively dry mud (*c*), and to have been thus forced to change its direction, and curve round to the right as shewn in the drawing. The part of this curve furthest removed from the pressure (*a*) still retains its concentric bands, while the nearer portion (*b*) is altered in character; and the cracks or crevasses (which are here very numerous), assume a direction more in accordance with the course of the stream. The old mud (*C*), over which the new stream does not extend, has been forced by the pressure into wave-like ridges; and *that* when it was not in so liquid a condition as the new stream, —a fact evinced by the different character of its surface. I may remark, that the waves or ridges last referred to are very different from those occurring in the second mud-slide.

4. The cracks or crevasses are a fourth peculiarity; but of these I can say little more, than that they correspond, as far as they go, with those which traverse the glaciers. Remarks which I have already made, and an examination of the drawing, will shew that on steep inclines, and under the effect of pressure, corresponding analogies are also apparent; as well as at the extremities of the streams in the mud-slide and glacier.

5. It may be permitted, in the fifth and last place, to draw attention to the different states of fluidity observable in the different parts of the mud-slide; and the difference of motion resulting therefrom. It seemed to me very probable that *at first* the upper part of the mud, even some time after motion has commenced, is in a more saturated state than the lower parts (I know that this was the case in one instance); and that it tends in consequence to flow down over its own inferior layers; so that the lower parts move more slowly, not only on account of their friction along the ground, but also from their inferior state of fluidity. It is possible, that this may be instrumental in the formation of the concentric bands;

but there are not at present sufficient data for investigating the effects of any such difference of viscous nature. After the surface has been long dry, experience shews that the lower parts may be very wet, and leads us to conclude, that the establishment of an equilibrium does sometimes result from that fact. It is matter for investigation and discussion, how far this and the preceding remarks may, or may not, be applicable to glacial motion. I trust that the careful illustration of an actual phenomenon—important in itself and in its bearings—may be found of sufficient interest to justify me in having thus trespassed upon the time and attention of the Section.

An Attempt to illustrate the Origin of "Dirt-bands" in Glaciers. By A. MILWARD, Esq. Communicated by the Author.

It will be remembered, that Professor Forbes, in his interesting work on the Glaciers of the Alps, describes the "dirt-bands" to be nothing more than curved bands of porous ice, the surface of which affords a readier receptacle to the drift of the glacier. He found the dirt to be superficial, and merely an indication that the glacier is made up of two kinds of ice, the one more porous than the other; so that the dirt lodges in the one more readily than in the other. The question to be determined is, how we are to account for the existence of the different kinds of ice thus regularly alternating. The dirt being merely accidental to this subject of inquiry, it will be better to speak of the dirt-bands, and the intervals between them, as the alternating bands of porous and compact ice.*

The dirt-bands are found to follow the direction of the hyperbolic curves marked out by the outcrop of the structural planes,—known by the name of the ribbon-structure. The ice forming the dirt-bands is made up of that structure, in the same way as the other ice; and depends, of course, upon

* These terms are, of course, only *relative*.

those laws in obedience to which the ribbon-structure originates. For this reason, the curve of the bands is, like that of the structure, found to be elongated low down the glacier, and compressed as we approach its source. We have thus only to account for the existence of bands of different kinds of ice, the form of *curve* of those bands being explained in the same way as that of the ribbon-structure.

It may be observed, that the superior distinctness of the dirt-bands, as we proceed lower down the glacier, is not necessarily an evidence that the bands of porous and compact ice are *there* more decidedly developed, but only that they are more distinctly apparent. And this, I imagine, arises from the fact, that the lower ice has been washed over for years; and thus the pores have become more discoloured by the deposit of drift than the pores of the corresponding porous ice above.

It was the remarkable similarity of the alternating bands on the mud-slide already described, to the "dirt-bands" on Professor Forbes' map of the Mer de Glace, that induced me to take an interest in the matter, and make a drawing of the phenomenon. In the first instance, the curved bands were a mystery to me; and I could not venture to found any argument on a mere analogy of *appearance*. The *second* mud-slide, however, seemed to shew me another step in the process; and, having explained the one from the other, I was led to ask myself whether the phenomena, to which one class of viscous fluids appeared to be subject, might not be common to another;—in other words, to a glacier.

In our first mud-slide we observe, *first*, the occurrence of curved bands; and, *secondly*, a difference of consistency in those bands. Our second mud-slide shews the origin of those curved bands, as far as mud-slides are concerned, to be the previous existence of ridge or wrinkles. Turning, on the other hand, to the glacier, we find curved bands of different consistency and similar appearance, which I have called relatively bands of porous and compact ice.

We may then fairly ask,—If, in one species of viscous fluid, alternate bands are derived from pre-existing ridges, why should not analogous bands in another species of viscous fluid

give rise to a *prima facie* presumption, that ridges are to be looked for in an earlier stage of that viscous fluid also? Is not the analogy just so far strong enough as to induce us to examine whether there is any trace of such ridges or waves; and, if so, whether their correspondence with the alternations of porous and compact ice is sufficient to account for the latter?

It is evident that such ridges or waves, if they do exist, must be very slightly marked, or they would not have been overlooked; but then, it is to be remembered, that the difference between the two kinds of ice is *also* very slight,—in fact, only barely apparent. It will be useless to look for them at the lower parts of glaciers, as they will have disappeared under the effects of atmospheric and other action through the lapse of many years, which will have degraded any existing ridges, just in the same way as in the case of outcropping strata.

There is also a tendency to the establishment of an equilibrium as to elevation, to say nothing of the disturbing effect of the lateral friction. It is, therefore, towards the head of the glacier, where the true glacial structure commences, that we are to look for such ridges: the best *time*, also, will be at the commencement of summer, after the disappearance of the snow, and before the confusion of the surface occasioned by the sun's influence.

1. It has been suggested to me, that in the case of the mud-slide, there may be an original difference of consistency in the bands of mud, which is only *increased* by the action of the drainage water; and that the ridges and intervals are the outcropping of these beds which compose the mud-stream. If there be such a tendency in viscous fluids to separate into beds of different consistency, such a difference of consistency may exist in glaciers, although the *actual ridges* may never be sufficiently developed to be apparent. Such a peculiarity of viscous structure would account for the bands of porous and compact ice, whether the ridges be found or not.

At present, however, we have *no proof* of such an internal structure, and may therefore dismiss it.

2. If, however, ridges or waves *are* found to exist, the case

becomes precisely analogous to that of the mud-slide: The lower extremity of each ridge will be more broken up than the other parts, just as we see the ridges and lower extremities of the several mud-streams to be broken up and more porous. From these high and broken parts, the water will drain and saturate, to a greater extent, the surfaces below. The ice thus saturated will become, by the action of frost, more compact than the rougher ridges. This fact, that saturated ice produces the most compact glacier, appears to have been already assumed (either from experience or otherwise), in the explanation which is given of the formation of the transparent blue bands of the ribbon-structure. An objection to which this explanation is open, will be found in the very different width of the porous and compact bands on the glacier; whereas in the mud-slide they are nearly equal.

In any case, however, it seems that there is sufficient ground why we should *look* for such ridges or waves; but at the same time, it is quite possible that they may be proper to a peculiar condition of viscous matter, to which class the glacier does not belong, or it may be that special resistance and obstruction prevents the development of such peculiarity in the case of glaciers. If this be so, the direct analogy between the glacier and the mud-slide in this respect vanishes.

3. From the manner in which the second mud-slide explains the first,—depending, it will be remembered, on the drainage of water altering the character of the mud,—another deduction may, I think, be drawn as applicable to glaciers, although not exactly in the same way. The result to which I am about to draw your attention *must*, I think, have a real existence. It is a result to which the dirt-bands *may* be the indication, or it may have passed altogether unobserved.

We find at the heads of most glaciers, where the *névé* is passing into ice, and the body assuming its normal form and construction, that there are steeper elevations, from which the *névé* descends, and frequently ice-cascades. The glacier is in these parts, on account of the abrupt descent, very much broken up, and often impassable. Now it appears evident, that, at the foot of these slopes, the water which has

passed more quickly down them will accumulate to a greater extent than if there had been no elevation behind, on account of the *change of inclination*. Now, during the summer months, the saturation thus taking place will be greatest, because of the large quantity of water then coming down. At this period of the year, likewise, the motion of the glacier is also greatest, and a large advance of the saturated body occurs. This, during the winter frosts, is consolidated, and formed, I imagine, into more compact ice than would have resulted from less saturated material.

On the other hand, in the winter months, that part of the glacier at the foot of the upper slopes, or ice-cascades, will be less saturated, as the surface of the whole glacier is then in a state of comparative rest, in consequence of the diminished effect of the sun's rays in thawing the surface of the *névé*. At this time, also, the glacier moves with far less rapidity; and so the quantity of glacier in a less saturated state thus moving on, will be considerably less than that advancing during the summer. In consequence, also, of its being less saturated with water, it will, after consolidation, be less compact than that which moved forward during the summer. Viewed in this light, the foot of the upper slopes, or ice-cascades, may be considered as a kind of laboratory for the manufacture of alternate bands of compact and porous ice,—the former made during the summer, and the latter in the winter months. Thus, if my theory be correct, a wide band of comparatively compact ice, and a narrow band of porous ice, will be annually formed and added to the glacier.

If these alternate bands be considered as identical with the porous and compact bands to which the dirt-bands belong, it follows, that the porous bands, during the progress down the glacier, become apparent by the absorption of the drift, which is washed over the surface, and their distinctness increases with the length of time during which they have been subjected to the drift.

Thus the wide compact band answers to the interval between the "dirt-bands," and the narrow porous band to the "dirt-band" itself. The one owes its formation to the summer, the other to the winter.

It will result also from this theory, that the breadth of the "dirt-band" and interval, taken together, should equal the annual advance of the glacier. And this appears, from observation, to be the actual case. We might also expect the relative breadth of the dirt-bands and interval to approximate towards the proportion of the winter and summer mean glacial motion. There may, however, be causes, arising from the positions and proportions of the lower and upper slopes at the source of the glacier, which would disturb this proportion between the two bands, even more than they would alter the relation between the two bands taken together and the annual glacial motion.

It is with the greatest diffidence that the writer would venture to submit, that a *prima facie* case has been made out for *three* subjects of inquiry.

1st, Whether there are indications of the existence of wide structural bands (of which the bands on the surface of the mud-slide are the outcrop) in viscous fluids and glaciers.

2d, Whether there are any traces in the upper parts of glaciers of ridges or waves answering to the ridges occurring on the mud-slide. And,

3dly, Whether the saturation at the foot of the upper slope, which must theoretically exist, is practically effective, so as to cause the alternate bands of porous and compact ice, in the manner which I have endeavoured to describe.

Fifteenth Letter on Glaciers; containing Observations on the Analogies derived from Mud-Slides on a large Scale, and from some processes in the Arts, in favour of the Viscous Theory of Glaciers. Addressed to the Rev. Dr WHEWELL by Professor FORBES. (With a Plate.) Communicated by the Author.

EDINBURGH, 2d December 1848.

MY DEAR SIR,—It is considerably more than a year since you did me the favour to communicate to me the interesting drawing and remarks by your friend Mr Milward, on a mud-slide on a large scale, which had come under his observation at Malta, and which led him to notice some interesting ana-

logies with the structure of glaciers. Again, last August, you communicated some farther reflections and observations by Mr Milward, and you invited me to send any remarks on the same subject which occurred to me, to be communicated, along with Mr Milward's papers, to the meeting of the British Association. I sent you, on the 11th of August, a letter, the chief parts of which I shall embody in this one, but which was not read at Swansea, in consequence of the pressure of business in the Geological Section, which barely admitted (as I afterwards heard) of Mr Milward's papers being read, and consequently no discussion took place. Since that time, Mr Milward, before returning to Malta, was kind enough to place his papers at my disposal, which I then offered to Professor Jameson for publication in his Journal, which he accepted, and now allows me to add my remarks on the same subject, which I address to you, as having been the introducer of Mr Milward's facts, and as having first desired my opinion with regard to them.

The phenomena presented by mud-slides on a large scale, are not now studied quite for the first time. About two years ago, I obtained a French work, entitled, "*Recherches Expérimentales sur les Glissements spontanés des terrains argileux, par Alexandre Collin, Ingénieur des Ponts et Chaussées.*" Paris, 1846. 4to. This interesting work, illustrated by plates, contains no allusion to the subject of glaciers;—the phenomena of mud-slides being considered solely in an engineering point of view. The principal object of the work is to investigate the form of the *surface of sliding*, which separates the solid from the moving soil of railway cuttings, embankments, and the like. That subject is not particularly connected with the one before us; but M. Collin has, at the same time, presented us with excellent and detailed sections of land-slips, the mere inspection of which recalls forcibly the outline of glaciers, and, although evidently unaware of my theory of the latter, his remarks confirm, in a very satisfactory way, several of my anticipations respecting the internal movements of viscous bodies. Thus, in the transverse section of an embankment of the Paris and Versailles railway (*Rive gauche*), Plate III., fig. 1., we find the

original declivity of forced earth, denoted by the dotted line, remodelled by the slide over the surface DFE into the bulged form FGH, which recalls at once the terminal section of a glacier. In fig. 2, again, we have a similar phenomenon, observed at Cercey in Burgundy, where the mass has been more solid, the swelling of the surface less continuous, and transverse crevasses, exactly like those of a glacier, have opened. The length of the *talus* or declivity, before sliding, was about 26 metres, or 85 English feet, in the first case, and 24 metres, or 79 English feet, in the second. M. Collin also measured daily, for more than two months, the horizontal advance of the lower extremity of the earth-slide of Cercey, and likewise the perpendicular fall of its upper extremity. These results, which are the only ones of the kind which I have met with, are highly interesting, as shewing the continuity and general regularity of this very small motion in a mass which could not be called *fluid*, in any ordinary sense of the word, since we are told that there was not the slightest trace of any exudation of water from the reservoir, of which the mass in question formed the embankment, and that "the absence of continued rain during the period of observation, singularly favoured the regularity of the descent." * But the best proof of the solidity of the material (a clayey soil, near the canal of Burgundy) is, that it admitted of being cut to permanent slopes of 30° , and even of 45° . The amount of horizontal movement of the lower end of the land-slip increased gradually during the first three weeks, and soon after ceased entirely; but the top of the slip continued to move during the whole continuance of the observations. This fact was confirmed by independent observations on a subsequent slip.† It follows, therefore, as a mathematical necessity, that the central parts of the slip being thus compressed, must either have discharged themselves laterally, or been heaped up vertically. An inspection of the change of figure of the displaced matter FGH, in fig. 1, which originally had the section EADF, plainly shews that the loosened earth was heaped up by the frontal resist-

* Collin, *Glissements spontanés*, p. 50.

† *Ibid.*, p. 54.

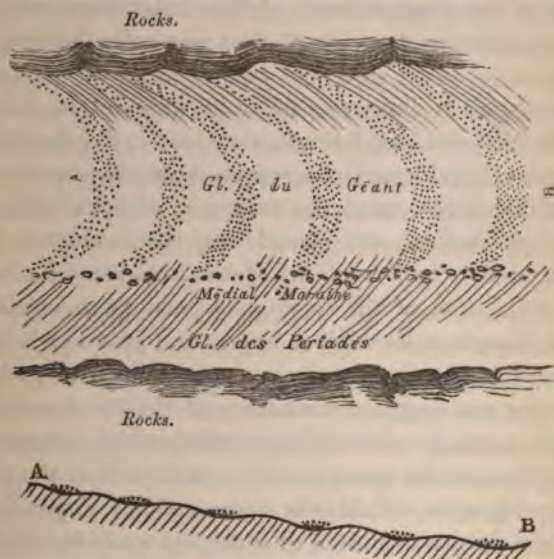
ance near H,—that the posterior parts of the mass *overrode* the anterior ones;—in short, gave rise to the *upward and forward* internal sliding motion, to which I ascribed, in the glacier, the phenomenon of the *frontal dip of the veined structure* (*Travels in the Alps*, 2d edit., p. 164). This condensation or swelling (*boursoufflement*) was noticed by M. Collin as characterising earth-slides, and the actual “ascensional movement” of the parts, due to the *quasi*-hydrostatic pressure, when a solid obstacle resisted the progress of the stream, is also admitted by him.* Of course, a mass of the mud or earth, of sufficient weight to produce an intense friction on a level or on a small declivity, would produce the same effect. In these observations, the daily motion of the terminal part of the land-slip varied from one-hundredth of a metre (0·4 inch) to a metre and one-third (4½ feet), but this last motion seems to have been the result of a sudden concussion; the steadiest motion was from half an inch to four inches daily.†

Having now attempted to do justice to M. Collin's interesting observations, I pass on to the papers of Mr Milward. This gentleman, being acquainted generally with the analogies lately attempted to be established between viscous bodies and glaciers, at once directed his attention to the peculiarities of *surface* of the great mud-slide which he witnessed at Malta. In the stream of the first slide he observed, under a favourable light, curved bands, alternately dark and light coloured, which, like their analogues, the *dirt-bands* of glaciers, are best seen from a height, and when the light falls obliquely. On close inspection, these bands were found to be composed (superficially) of smooth, fine mud, and of rough, coarse mud alternately, the latter being somewhat the higher of the two. In a second case of a mud-slide, he found that the smoothness of the mud was a superficial phenomenon due to

* Collin, *Glissements spontanés*, p. 47, and Plate XI.

† My friend Mr John Thomson (of Glasgow), in a short note with which he has favoured me, states that, in his experience of making railway embankments (in Leicestershire), he has found concentric waves or wrinkles pressed out of the soft clay of the embankment, in proportion as the load of earth increases.

the settling of the more fluid part in slight depressions existing between "the rough bands, which were raised from a foot-and-a-half to two feet, so as to form *ridges, or waves, or wrinkles*, swelling and falling over." The sketch given of these "wrinkles" is shewn in Fig. 2. Mr Milward was not aware that the analogous phenomenon was discovered by me in glaciers as far back as 1843, and described in my *Fifth Letter on Glaciers*,* where I have given the accompanying plan and section representing them. It must be as satisfac-



tory to Mr Milward as it is pleasing to me, to find that his shrewd conjectures as to the probability of their discovery, although based solely on the analogy of viscous fluids, are thus perfectly confirmed. They were, in fact, discovered in the *place* and at the *time* that Mr Milward supposed they would be, and they were already designated by the very term he uses, "wrinkles," years before he wrote of them. "It will be useless," he observes, "to look for them at the lower parts of glaciers, as they will have disappeared under the

* Edin. New Phil. Journal, 1844, p. 117, and Appendix to Travels, 2d edit., p. 419.

effects of atmospheric and other action. . . . It is, therefore, to the head of the glacier, where the true glacial structure commences, that we are to look for such ridges: the best *time*, also, will be at the commencement of summer, after the disappearance of the snow, and before the confusion of the surface occasioned by the sun's influence."* In point of fact, it will be found, from the reference above, that the glacier *wrinkles* were observed on the Glacier du Géant, at the upper part of the Mer de Glace;—and that the season was that of the disappearance of the winter snow, which lay in wreaths between the ridges, thus perfectly defining their contour.

With respect to the *origin* of these wrinkles in the Mud Slide, Mr Milward has, I think, very justly, rejected the explanation of them formed on a supposed alternation of beds or strata of different texture, the existence of such beds being entirely hypothetical, and considering the manner in which such a mud-slide is formed, utterly improbable. In looking for an explanation of the analogous phenomena in glaciers, it would, therefore, be wise to try to find one which should hold good in a mass of *uniform* consistence, and rather to look for the less compact structure of the ice beneath the *dirt-bands* as an *effect* of the same cause which produces the wrinkles, than as the cause itself. I believe that the phenomena of ridges or wrinkles is a *general* one, depending on the toughness of a semifluid or semisolid mass forcibly compelled to advance or extend itself; that the *periodicity*, or repetition, of the wrinkles at nearly regular intervals, is due to mechanical causes alone, and to no variation of internal consistence.

Having successfully imitated these wrinkles in my experiments, I think that I am able so far to account for them. Although neither mud nor plaster is capable of retaining the *internal* veined structure of the frontal dip, which bears evidence of the direction of the slide being such as I have stated. That evidence is to be found in the glaciers themselves, in certain cases of lava streams, which I have else-

* Phil. Trans., 1846.

where described,* and in Professor Gordon's beautiful experiment with brittle pitch in motion.†

A body soft enough to convey a pressure partly hydrostatic, or one acting in *any* direction,—if it be tenacious enough,—always tends to *crease*, or have its surface near the point of pressure pushed upwards and forwards relatively to the surface farther off. A heavy weight laid on a tough paste will raise a wrinkle round it, but at some distance; farther off in proportion to its toughness. So railway embankments raised on a boggy bottom force out a crease, or two or three successive parallel creases, on either side; and, I daresay, you recollect that one effect of the great land-slip at Lyme, some years ago, was to elevate a ridge of shingle above the level of the sea at some distance from the shore. A succession of equidistant wrinkles will be formed whenever different parts of a plastic body are subjected in succession to a pressure violent enough to produce *detrusion*, or sliding amongst the particles. Thus, if a very viscid fluid is poured in a gradual stream upon a flat surface, so that it may spread uniformly, a succession of circular creases is formed in consequence of the hydrostatic pressure from the heaped-up centre becoming sufficient to overcome, for a moment, the viscosity at a certain distance from the centre; as the circumference rises in a crease, the centre falls, the central pressure *suddenly* diminishes, and if the stream continue to be poured uniformly upon the centre, although the circles will expand slightly, it will not be until a sufficient *head* is again raised to overcome suddenly the viscosity of the fluid that a new wrinkle is formed in exactly the same relative position as the first.‡ Treacle, mortar, tar, and similar bodies, usually present such creases when poured out. What has now been said of a viscid mass spreading uniformly from a centre applies equally to one confined in a trough with parallel sides, if constantly fed from one end. A succession of waves are thus formed, as in Mr Milward's mud-slides, or as

* Phil. Trans., 1846.

† Phil. Mag., 1845, vol. xxvi., p. 206.

‡ The steps of this process are attempted to be illustrated by the curves in Plate III., fig. 4.

in a glacier. They become confounded or not at a distance from the origin; *that* depends entirely on the rate of motion of the stream at different points, which again depends chiefly upon the declivity of its bed.

These wrinkles or creases, then, do occur at *regular intervals*, even in bodies perfectly homogeneous, and, under external circumstances, perfectly uniform. The intervals of such waves depend, in these cases, solely upon the physical qualities of tenacity, specific gravity, &c., of the body, and the more or less ample stream which furnishes it. We perceive here nothing like an *annual* recurrence; and this circumstance at first puzzled me, the intervals between the dirt-bands of the Mer de Glace (which are evidently the same with the wrinkles) being, as observed by me at the very time of their first discovery, so nearly consistent with what I supposed to be the annual motion of the Ice Stream, and which was afterwards confirmed by direct experiment, as scarcely to allow us to suppose the coincidence fortuitous.

But an easy experiment establishes the analogy perfectly. If the stream of plastic matter already supposed be *not* uniformly supplied, but arrive in *gushes*, every such overflow, by the rapid rise of the *head*, throws off a wrinkle in the most regular manner. So that, for example, on examining those plaster models, formerly repeatedly described by me, in which cupfuls of white and of blue plaster of Paris were alternately poured down an inclined channel, each separate flow was found to constitute a wave or crease. In a glacier, especially in its higher regions, the difference of summer and of winter velocity is sufficient to produce what may be called (relatively) a gush; and I suppose that the wrinkles are formed in most glaciers at the foot of the steep of the *névé* (as Mr Milward also believes), where a pressure *à tergo* is produced by the heat of the short summer, sufficient to overcome the incalculable resistance which a mass of half-frozen snow, hundreds of feet thick and hundreds of yards wide, presents, to be squeezed and moulded, after the manner of a semi-fluid, into a convex wrinkle. Of the *fact* there is no doubt. Each wrinkle, then, is nothing else than a local swelling, such as those figured by M. Collin, taking place at the moment when

the upward and forward force due to the quasi-hydrostatic pressure of the mass becomes insupportable, and gives rise to the forced separation of the cohering substance by countless fissures, constituting the *frontal dip of the veined structure* of the glacier, whose position, taken in connection with the *wrinkles*, is shewn in fig. 5.

I farther beg leave to direct your attention to a very curious illustration of these views which I lately noticed. In the mechanical turning or planing of malleable iron, the spiral shavings have a structure which is truly remarkable, and shews convincingly that the effect of a steady pressure upon a semisolid or plastic body, is really such as to produce not merely wrinkles or creases on the surface, in the usual wave-like form, advanced in the centre, and withdrawn or retarded at the sides; but that the shaving has its particles squeezed *upwards and forwards*, as I have maintained that the mass of ice is, in consequence of the intense frontal resistance, and when the tenacity of the metal is pushed to its utmost limit of endurance, *detrusion* takes place at *intervals sensibly equal*, as in one of the specimens herewith sent,—being nothing else than the wrinkles exaggerated, and the bruise producing the veined structure pushed to an actual separation. (See fig. 6.) These specimens (and such may be found in the workshop of almost any machine-maker)* have the higher degree of interest, because *the surface of detrusion makes so very large an angle with the line of pressure*. This process of heaping up by internal sliding of the parts of a semifluid mass was pointed out by me, I believe, for the first time, as applicable not only to very tenacious bodies, but even to streams no

* They are not so common as I supposed when I wrote this; they are principally to be found when *coarse* planings are made from iron of not the very best quality, and not lubricated with water. The finest iron is *too* plastic. On mentioning recently these observations to Mr James Naysmith of Manchester, he stated it to me, as a fact familiar to practical men, that, in turning a cylinder three feet in circumference, the shaving, *owing to frontal condensation*, and the over-riding of the parts, is perhaps only two and a half feet long. How perfect the analogy with what I have always maintained to be the mechanism of the glacier! It is this thickening, amounting to one-fifth part, which compensates during winter, the summer's waste.

more viscid than common water. But, I concluded that, when the frontal resistance (due to friction and cohesion) becomes very great, the planes of least resistance may assume an inclination of 60° or more, a notion which has been treated as practically untenable by a mathematical critic of my theory, whilst he admits that it is theoretically possible. The iron shavings in question demonstrate the truth and feasibility of my anticipation. There is no difficulty in determining the exact line of pressure, for it is obviously that in which the tool is made to act, or it is mathematically parallel to the flat side of the shaving itself, if we suppose it straightened. (Fig. 7.) In one of the specimens now before me, the planes of detrusion or frontal dip, make an angle, as nearly as can be estimated, of *seventy degrees*, with the base or line of pressure. From the *fibrous* appearance of the whole mass, I have little doubt that it is traversed by numberless fissures or flaws parallel to the planes of actual sliding, flaws which might probably be made evident by immersing the whole in dilute acid.

Time does not allow me to add more. Some may consider these approximations and analogies trifling, but I persuade myself that you will not do so, being well aware how much has resulted in the progress of science from the patient study of minute facts not obviously related to one another. It is some pleasure to me to persuade myself that my speculations upon the cause of the motion of glaciers have had some slight influence in drawing attention to the loose manner in which bodies have hitherto been classified as solid and fluid, rigid, flexible, or plastic. On the one hand, attention is directed to the way in which stress or strain is exerted upon masses, and modified by their internal constitution in a way which no theory not embracing an expression of that constitution founded on experience, can possibly represent. On the other hand, the imperfect views which practical men have entertained as to the manner in which intense strains affect materials of certain kinds, and in certain forms, are apparently about to undergo a considerable revolution. I remain, my dear Sir, yours very truly,

JAMES D. FORBES.

Rev. Dr WHEWELL.

Geological Notes on the Valleys of the Rhine and Rhone. By
ROBERT CHAMBERS, Esq., F.R.S.E., &c. Communicated
by the Author.*

Alluvial Terraces and Deltas.

The alluvial terraces in the valleys connected with the Alps, have been referred to by M. Saussure, Mr Playfair, Professor Studer of Berne, and other eminent geologists, but not with that degree of attention which they seem to merit. Mr Playfair says,—“ The changes that have taken place in the courses of rivers are to be traced, in many instances, by successive platforms of flat alluvial land, rising one above another, and marking the different levels on which the river has run at different periods of time.” He speaks of these terraces as very conspicuous at the Rhine; one, of which he measured the height, was 122 feet above the present surface of the river. He adds,—“ When it is considered that three, or even four, such terraces can often be counted on the banks of this great river, it may fairly be stated, that the evidence of the Rhine having flowed at the height of 380 feet above the present level is very conclusive.” M. Studer considers these terraces as indicating “ alternations of the epochs of repose and activity.” From the very general neglect of the superficial formations, we are left without any more definite information on this subject, and no plausible hypothesis has as yet been suggested as to the actual circumstances under which the great detrital deposits of the plain of Switzerland were laid down, and these terraces in the valleys produced.

In the course of a recent tour in Rhineland and Switzerland, I was able to make a few observations on the superficial formations in various districts, and also to make some approaches to what I consider a satisfactory conclusion regarding the formation of river terraces. In venturing to lay the results before the Society, I trust to meet with that indulgence which is due to those who advance into a comparatively little investigated field, and whose speculations are aided by little collateral light.

* Read to the Royal Society of Edinburgh, on the 5th December 1848.

The valley of the Rhine is composed, in the neighbourhood of Cologne and Bonn, of a wide alluvial plain, bordered by low eminences. The plain is composed of sand chiefly, but partly of a small gravel. A little way back, it is bounded by a low cliff, at the top of which commences a second alluvial plain, also of considerable breadth. At Bonn, the plain nearest the river is more elevated above it,—probably not less than 45 feet; and the rise to the second plain is also greater, perhaps 20 feet. These objects are conspicuous from the railway, which, on leaving the upper plain, has to proceed for some way along a high embankment.

On emerging from the contracted part of the valley, where the Rhinegau terminates, we see great benches of ground a little way back, much like those terraces which have elsewhere been set down as ancient sea-margins. The chateau of Johannisberg is seated upon one of these. Similar terraces appear between Bieberich and Wiesbaden, and behind Mainz; one behind Mainz is exceedingly well defined, and, perhaps, may be found to correspond in level with one on the opposite side of the river, which I observed, near Cassel, to be composed of nearly pure sand.

At Basle, where the surface of the river (if I rightly understand Keller's map), is 863 English feet above the level of the sea, the usual low plain adjacent to the river is backed by a higher alluvial plain, with a steep cliff intervening. This is well seen to the east of the city, on the road to Lucerne. The upper plain may be 70 feet above the lower. The arrangement has an unusually interesting appearance at the confluence of the Birs with the Rhine, the side river having made a transverse cut in the upper plain, so as to form in it a little valley bounded by flat-topped cliffs.

In ascending the eminent ground which intervenes between Basle and Schliengen, in the grand duchy of Baden, we pass over terraces of considerably greater height. These are the highest alluvial terraces which I have had an opportunity of seeing in the immediate valley of the Rhine.

Passing to the valley of the Rhone, the side vale of the Arve presents such alluvia on a very great scale. This turbulent stream, as is well known, descends from the skirts of

Mont Blanc, and, after a course more remarkable for rapidity than length, joins the Rhone about a mile below its issue from Lake Lemman at Geneva. The course of the Rhone, on issuing from the lake, is through what may be called a deep alluvial trough, on the bottom and sides of which the city of Geneva is built. The Arve, near its junction with the Rhone, flows through a similar trough, one side of which is overhung by the Salève mountains. When we proceed in our examination of the Arve valley, we find that it is filled from side to side with a deep detrital formation composed of the rocks of the Alps, and of which the alluvial sheet around the junction of the rivers is a continuation. For many miles, this may be traced up the Arve valley, everywhere forming the terraced sides of a deep trough or cut in which the river runs. Supposing, indeed, there were no such trough for the river, the valley of the Arve from Bonneville downwards, might be described as having a smoothly-sloping floor of gravel and other detrital matter; and it might, on a similar supposition for the Rhone valley, be added, that this alluvial sheet, after passing out from among the mountains, advanced across that valley, so as to form a barrier at the lower end of Lake Lemman. Thus, to abstract the troughs in which the rivers run, is merely to trace backward the course of geological events for a step, for we are warranted by some of the oldest and most settled observations of that science in believing, that these troughs have been cut by the rivers out of a formation which was previously without any such intersections. Laying aside for a brief space farther speculation on the circumstances attending both the formation and the intersections, I may remark, that the general appearance of the alluvium between the Salève mountains and the lake, is that of a plain, with very slight inequalities. In reality, however, it rises from about 100 feet above the lake, which is the elevation immediately behind Geneva, to 165 feet, at a point about two miles to the south-eastward, where, for a considerable space, it is perfectly flat; after which the gentle rise is resumed without interruption for several miles. Within the walls of the Arve valley, the terraces appear to follow this gentle inclination on both sides of the river pretty uniformly; but at

Nangier, I observed that it was interrupted by a sort of bank, after which the equable inclination was resumed. At the eastern extremity of the Salève mountains, a remarkable object is presented, in what may be called a patch of the alluvial formation left attached to the face of the hill, surrounded, of course, on all sides, with steep-down banks; for which reason, the spot has been taken advantage of in early times for the site of a baronial fortalice,—a conspicuous object during the first stage from Geneva to Chamouni.

The northern shore of Lake Lemman, being that which is presented to the low country of Switzerland, is generally low and tame. The eye of the geologist is, nevertheless, attracted, between Rolles and Lausanne, and particularly about Morges, by alluvial terraces of various heights, and with perfectly level tops, which overlook the lake, sometimes two being presented at one place, the one above and a little behind the other. That these are memorials of former levels of the lake cannot, for a moment, be doubted. Their whole range, however, is probably not more than a hundred feet. Towards the east, the comparative boldness of the shore seems to have forbidden the formation of such alluvial terraces; but at Vevay, under favour of the recess in the hills at that place, there is a series of grand character, to which some previous observers have pointed attention under the persuasion that they are ancient *moraines*. Their composition and form establish them, in my opinion, as alluvial formations, produced in the usual manner by water. There is here a short, but powerful stream, descending from the neighbourhood of St Denis. In the recess through which it pours on its approach to the lake, the terraces are seen on both sides, sloping down from the opening, with very equable surfaces, forming the best vineyard grounds of the district. Two pairs, if I may so speak, are more conspicuous than the rest; one is at the height of 165 feet above the lake, being thus identical in level with the plain already alluded to, as existing on the sloping alluvial sheet near Geneva. The other is about 442 feet above the lake. A third more faint, affording a site for the old church of Vevay, is about 108 feet above the same level. It is evident, that the space between the

two terraces, in each case, has at one time been filled up at an equal height, so as to form one sheet of alluvial matter, exactly such as a mountain stream may be seen, at this moment, forming in its descent towards a recipient lake, partly above and partly below the water. I therefore conclude that this little river formerly met a recipient body of water much higher than the present lake; at first, at nearly the height of the upper terrace, afterwards, at the height of the next lower one, and so on; a cut being always made in the one sheet of alluvial matter on the recipient body falling to the level of the next lower, until the place became a recess winged with terraces, as we now see.

It was Mr Darwin who first suggested the manner in which ancient deltas were thus intersected, when speculating on such objects, in his well-known paper on Glen Roy. He had observed, that, at the mouths of the little side-valleys in Glen Roy, there were laid against the hill on each side what he calls "obliquely-truncated buttresses," composed of highly-inclined layers of sand and coarse gravel, the top being, in some instances, on a level with one of the shelves or ancient beaches of the valley. Sometimes a series of these buttresses occurred, one below another. The rivulet of the connected side-valley he shewed to be constantly engaged in removing matter from these deposits; never does it add any. He goes through a process of reasoning, from which he thinks "it becomes evident that the materials of which they are formed were accumulated through the agency of the stream, although it is, at the same time, inconceivable that they were left on the steep slope by a force which, as it now acts, is steadily at work, tearing away matter in its whole downward course." He then argues for the necessity of an intervening cause in the action of the streamlet, and, seeing the connection of the flat tops of the principal buttresses with lines formed by the surface of a body of water occupying the principal valley, demonstrates that that sheet of water must have stood at as many levels as there are buttresses, receiving the matter of these from the side streamlets in the form and character of a delta; the whole being "unequivocal evidence of the check which matter drifted by a

current meets with, when it arrives at or near to the surface of still water." Such is a brief outline of Mr Darwin's ingenious analysis of these objects, which, nevertheless, have been since set down by geologists of no small repute—blinded by an over-ridden theory—as the moraines of ancient glaciers.

It happens that the truth of Mr Darwin's views is demonstrated by an example of the very process which he describes, now actually in operation. I may first remark, that deltas are common on the borders of the Swiss lakes, and also in valleys where mountain-streamlets descend to join the rivers. At Alpnach, for example, near the Lake of Lucerne, there is a fine specimen, a sloping, rough surface between the outpour of the stream from its native mountains and the river into which it is received. The stream itself, in ordinary times, keeps within a wide, stony channel, but in floods sweeps over the whole surface, to which it thus gives shape. The great plain between the Lakes of Brienz and Thun, is simply the delta of the Lutschine river, here pouring towards the Aare, from its source in the side vale of Lauterbrunnen. The composition of the ground, and the slight declination of the surface from the opening of that valley towards the lakes, leave no room for doubt on this point. Such a delta has been observed in the course of formation, in modern times, on the border of the Lake of Thun, where, a new opening having been formed for the Kander river early in the last century, there is already formed round its mouth a large sloping projection of exactly this character, the process having, no doubt, been hastened in this case by the abundance of materials resting along the sides of the river near its junction with the lake. So much for the history of the formation of such deltas. Let us now advert to the circumstances under which they are cut down.

The elevated Lake of Lungern, in the canton Unterwalden, has been, as is well known, lowered, for economic purposes, within the last sixty years. Where the head of this lake formerly stood there is an assemblage of deltas, connected with various mountain streamlets, the proper affluents of the lake. We see these deltas, now lying high and dry, with pretty sharp edges and somewhat steep cliffs a little within

the ancient water-line. Their most remarkable feature, however, is the miniature valley which has been carved out, in each case, by the stream, in consequence of the changed relations of the lake. It appears that the stream, on no longer being received into the body of still water, has begun to fall, as a sort of cascade, over the steep front of the delta. The matter being soft, has readily given way, and been carried forward into the diminished lake. The stream has thus worn a way back towards the mountains, exactly as the Niagara river is believed to do with the rock over which it descends. It therefore appears to be demonstrated, that, while a delta is formed by the connection of a recipient body of water with a river producing detritus, the cutting down of such a delta is the consequence of the withdrawal of that body of water.

The same explanation serves for the peculiar forms of valley alluvia already described. These, indeed, are neither more nor less than deltas confined between parallel ranges of hills. I conceive, that in every such case, there has been a recipient body of water up to the highest point where any such formation is found. Into this the detritus of the stream is thrown, and there deposited in an equable slope. While such continues to be the relation of the objects, nothing like the formation of a trough or valley in the alluvium can take place. For that process, it is necessary that the body of still or recipient water be withdrawn, in which case the detrital sheet formerly lying under still water is left under a sub-aërial exposure; the stream once received into the still water, now runs over the exposed alluvium: on that it exercises, of course, a wearing power, while seeking a line of descent conformable to its new circumstances. A hollow or valley is consequently formed, the removed matter being always carried forward into the receded body of still water. Thus a body of water might retire down a valley, so as to allow of fresh formations being deposited, to be in their turn cut down by the stream, until final rest was obtained in a lake of the present era, or in the sea at its present level.

In speculating on such bodies of water, it seems natural, in the first instance, to think of inland lakes, and to suppose that these have been discharged by the giving way of their

ancient barriers. In reality, the discharge of lakes by the giving way of their barriers is a rare event in nature; and when it does take place, there can scarcely fail to be some remains of the barrier to commemorate the event. It has not been observed, that the phenomena in question are presented more or less conspicuously in every valley, while indubitable appearances of ancient barriers are scarcely anywhere pointed to, and in many cases it is inconceivable how they could have either been formed or removed. For instance, in the present case, no barrier in the valley of the Rhone would suffice to sustain the waters of Lake Lemman at 442 feet above their present level, seeing that, on their exceeding a rise of 240 feet, they would pass over the height of the country between Geneva and Neufchâtel, and consequently be discharged into the valley of the Rhine. The idea of lake barriers, indeed, appears to be the mythical stage of the investigation. When many valleys have been carefully examined, without presenting a single feature in support of this action, it becomes an unavoidable alternative, that we suppose the sea to have formerly stood at a higher level—I do not say, absolutely, but in relation to the land, so as to fill the valleys with estuaries, and be concerned in the formation of these ancient alluvia. I venture to affirm, that no one could examine many valleys as I have done, and invariably trace such alluvial formations from the open country near the sea, without any interruption up to the base of the great chains of hills from which the rivers originated, without concluding that the only recipient body of water concerned in the case was the sea.

Under this view, it becomes of importance to learn how high such formations can be traced in the Alpine valleys. We have already adverted to examples at Basle, between 900 and 1000 feet above the level of the sea, and to the ancient alluvia of the Arve valley, which ascend to nearly twice this elevation. But these do not express the full height which the sea has attained in these vales during the alluvial period. The Lake of Thun is 1875 feet above the sea. Its affluent, the Kander, passes through gravel terraces, which, at no great distance from the lake, are at least 150 feet above

it. This indicates a former level of the sea at least 2000 feet above the present. In the connected valley called the *Simenthal*, there are such ancient alluvial formations ascending to even a greater height, their range being between 2200 and 3000 feet above the present level of the sea. I fortunately have not to stand unsupported in these particulars; for, according to Mr Playfair, Saussure "found proofs of the running of water on the side of Mont Salève, at least 200 toises above the present superficies of the lake (of Geneva);" that is, at a total elevation above the sea of at least 2507 feet.

Before parting with this subject, we must revert for a moment to the alluvial sheet at the junction of the Arve and Rhone. Under the light which we now have regarding the circumstances necessarily attending such formations, we might safely affiliate the whole of that sheet to the Arve, even if the rocks of which it is composed did not tell the same tale. Undoubtedly, the Arve has discharged the whole of this matter into the valley of the Rhone, while there was a body of still water at a sufficient height to receive and spread it out. It was, in fact, a subaqueous deposit thrown across the valley as a sort of barrier at this place, and such must have been its character, when first the withdrawal of the recipient body of water left it fully exposed. As a barrier, its function was to confine the waters of Lake Lemman, which originally would stand at least a hundred feet above their present level, and so would continue to do till the Rhone had worn out the trough or valley in which the city of Geneva now stands. The wearing of this trough, it may be remarked, has only produced a partial reduction of the blockage, so that it may still be said, that this detrital discharge of the Arve in an early age, is the immediate cause of Lake Lemman, at least of there being a lake at this place of precisely such a level. For many of the lakes of our own country, I believe that an origin could be traced in exactly such a course of events in the alluvial period.

Ancient Lake-Beds.

Two unequivocal instances of ancient lake-beds occur in

the valley of the Arve; but the obvious cause of their formation is so peculiar and extraordinary, as only to support the rule above propounded. Hitherto, as far as I am aware, little stress has been laid upon them, and the principal lacustrine features have been overlooked.

They occur at a short distance above Chamouni. Professor Forbes and others have described with great exactness the ancient moraine of the Glacier des Bois, or *Mér de Glace*, which crosses the vale of the Arve immediately above the village of the Les Tines. It is a huge barrier of rough blocks, mingled with smaller detrital matters, leaving only a narrow passage for the river. No doubt is entertained that the *Mer de Glace*, in ancient times, instead of merely entering the valley, as it now does, was of such greater volume as to pass across it, and abut against the opposite mountains, under the *Croix de la Flégère*. The barrier in question was the moraine which then skirted its right side. The unavoidable effect of such a blockage of the valley would be to dam up the waters of the infant Arve, and form them into a lake of a height not less than that of the barrier. Such a lake would continue to exist as long as the barrier remained entire. Now, in the mile's space above the barrier there are clear memorials of this lake at three successive stages of elevation, —in three alluvial terraces distinctly traceable along the right side of the valley. We are to presume, that the uppermost of these is the indication of the first height of the water; that a break of the barrier then took place, covering the lake to the level of the next terrace, and so on. Such features are the more striking, inasmuch as, for many miles below Les Tines, the valley shews scarcely any remains of alluvia above the level of the meadows now in the course of being formed by the river.

At the village of Argentiere, where these terraces melt into the rise of the vale, another glacier comes in; and here occurs the second barrier, which originated in precisely the same way, and also caused the formation of a lake, though in this case we can only trace the memorial of one intermediate level of the water, after the first had been reduced.

Rock Smoothings and Erratic Blocks.

I willingly give my testimony to the striking character of the smoothings observable on the rocky slopes by the way-side, between Servoz and Les Ouches, in the valley of the Arve. These are far below any present seat of permanent ice ; but I think it is impossible to examine them without being convinced that a glacier has at one time descended through this part of the vale, and worn and polished the rocks in its passage.

The smoothing of the precipices at Montanvert, from one to two hundred feet above the present bed of the Mer de Glace, was pointed out in distinct terms by Professor Forbes, who at the same time discovered traces at this place of the ancient lateral moraine of that distinguished glacier. All of these objects seem to me beyond question, and their connection with the barrier just alluded to is very interesting.

There are smoothings, however, in certain situations, where an ancient glacier, or an existing glacier in a larger volume and more powerful action than at present, is not so readily imagined. At the elevated *col* between the Arve valley and the Val Orsine, smoothings are seen on both sides to a considerable height. It has been thought that the Glacier D'Argentiere had passed over this col ; but I am at a loss to imagine its doing so in any circumstances. Even admitting however, that such might have been the case, no such explanation will account for precisely similar smoothings which I observed on the face of the lofty Aiguilles Rouges, right over this spot, a situation of great elevation, and entirely unconnected with any imaginable glacier beds.

In the valley of the Rhone, between Martigny and St Maurice, the rock-faces near the bottom, on the side skirted by the road, are in many places worn and smoothed, very much after the manner of those near Servoz. There are some good examples at Barme, where the hill advances a good deal, so as to contract the valley. On the theory which has been started, that a glacier once passed down the Rhone, such appearances in such a situation are exactly what might be expected. It is remarkable, however, that at the more

striking contraction of the valley at St Maurice, the bold precipices overhanging that town shew no such appearances. Here, nevertheless, there are memorials of some mechanical agency of the kind speculated upon, for a low hill between St Maurice and Bex presents smoothened surfaces above the soil in many parts. I cannot say that my observations in the valley of the Rhone very greatly favoured the idea of its supposed glacier, though I am far from saying that they were either extensive or minute. One particular in the smoothings which have been pointed out by Professor Forbes in the high valley of the Sallench escascade (Pissevache) struck me forcibly, that they were not sloping in the direction of the valley, but maintained a horizontal tendency, even at the place where the walls of the valley turn round to join the valley of the Rhone. In that case, it certainly appeared to me that ice borne upon a sea at the proper level was the more plausible hypothesis.

At Monthey, two miles below St Maurice, and exactly opposite the village of Bex, there is a prominent hill, on the face of which, from 200 to 250 feet up, is presented the zone of blocks of which Professor Forbes has given so interesting a description. For several miles along the hill-side, generally about one level, these blocks occur—enormous, undressed masses of granite and other primitive rocks, resting on the secondary formation which constitutes the hill. Mr Forbes has been unable to surmise for them any other explanation, than that they are the remains of a moraine formed by the supposed ancient glaciers of the Rhone valley. It is remarkable, however, that they are just about the height of the great superior terrace at Vevay, so that we may suppose the sea to have once had this very spot for its margin. In that case icebergs might transport the blocks from the skirts of glaciers in the higher parts of the Rhone valley, and being, as was very likely, intercepted by the projecting hill on their way out to the open sea, might deposit them here. Perhaps a rigid ascertainment of the levels of the Vevay terrace and the zone of blocks might enable us to treat this hypothesis with somewhat greater confidence.

The zone of blocks on the face of the Jura mountains above

Neufchâtel is a precisely similar phenomenon to those of Monthey; but they are eighty miles from the seat of Alpine granite, and are described as not less than 2500 feet above the level of the sea, while those of Monthey are only, on a rough calculation, about 1670. The means by which these primitive masses, including the celebrated Pierre-a-Bot, were borne from their original seat and quietly placed on the surface of the Jura limestone, has been the subject of much speculation; and I need not particularly describe the hypothesis of Professor Agassiz, to the effect that glaciers passing across hill and valley at an almost inappreciable angle of declension formed the vehicle of their singular progress. It will readily be observed that a simpler hypothesis is now put within our reach, in as far as the sea appears, from alluvial formations in the Simmenthal, to have formerly stood at a height even superior to the Neufchâtel blocks, while M. Saussure acquaints us with water-markings on the Salève mountains of (as it happens) exactly the elevation of these erratics. In short, it seems far from improbable that icebergs floating off from the skirts of glaciers, have been the real vehicles for the blocks in this as in the other case.

It will be observed that my observations do not lead to the advocacy of any exclusive theory. I admit ancient lakes in certain peculiar circumstances, but deny their concern in all the appearances usually attributed to them. I admit most readily the more extensive and voluminous glaciers of ancient times, but suggest that blocks have been carried, and fixed surfaces smoothed, by other means. Perhaps it would be well if, in scientific speculation, we were to keep our eyes more open than they generally are to diversified causes for similar or nearly similar effects.

On the Smoothed Rock Surfaces of the Porphyritic Hills of Hohburg, near Wurzen. By Professor NAUMANN.

The most interesting phenomenon in these hills is indisputably the occurrence, by no means uncommon, of smoothed
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and polished rock-surfaces; and although these small eminences of our otherwise level country, neither by their form, nor by their height, remind us in any respect of the Alps, yet we are astonished by finding, on their surface, phenomena of attrition similar to those which are so frequently exhibited by the rocky bottoms of the Alpine valleys. If anything whatever could justify the almost ironical appellation of "Hohburger Schweitz," it would certainly be this remarkable phenomenon which the diminutive hills of our range possess in common with the colossal mountains of the Alpine regions.

On closer inspection, the smoothings of the rock surfaces among the porphyritic hills of Hohburg, although they have a general resemblance to those of the Alps, are yet found to be sufficiently distinct from them, to prevent us from being entitled at once to identify the two with one another, or attribute them both to the same cause. The smoothed surfaces, indeed, exhibit among themselves so much difference of character, as to render it necessary to separate them primarily into two divisions. Those of the one kind are really surfaces smoothed by grinding; while the others can only be called surfaces of erosion. Both occur only on the exterior of the rocks, or of the blocks which have been broken away from them. On the blocks they sometimes occur on two sides, and even in various directions on the same side; but, on the solid rocks, the scratches always agree with one another in their direction, although that direction is in some degree dependent on the locality.

From the whole of the phenomena, Naumann draws at last the following conclusions:—

(1.) The grinding and eroding material can have been, for the most part, nothing else than finely comminuted stone, such as is met with in the sand and sandy clay of the district. This is indicated by the great uniformity of the attrition, the constant formation of the same pattern on the same scale, the small length, breadth, and depth of the scratches, the entire absence of large and greatly lengthened grooves, the sharpness of the edges of such blocks of porphyry

as are ground on more than one side, the occurrence of smoothed surfaces on the walls of narrow clefts, and, finally, also, by the absence of all foreign rolled stones and blocks on the porphyritic hills. Now, since masses of sand and clay cannot be supposed to have moved forward of themselves, we require the assumption of some transporting agent.

(2.) The grinding material must have been borne along the rocks under a heavy pressure. Without pressure, the grinding action is inconceivable. This pressure could not have been due to the grains of sand themselves; at least, the smoothing of vertical or overhanging cliffs, as it occurs here, cannot possibly be explained on such a supposition.

(3.) The moving force can have operated only slowly, and must therefore have continued in action during a considerable time.

(4.) The moving force must have been regular, and have acted constantly in the same direction.

(5.) The vehicle of the grinding material cannot have been water. It would have been impossible for water to have cut out parallel grooves by means of sand. Above all, the idea of violent and sudden cataclysms must be excluded.

(6.) The vehicle of the grinding material must have been a firm mass, but yet must have possessed the character of plasticity in some degree, however slight. That it was not a fluid mass, but a firm and stiff one, is evident from the following considerations; namely, that no substance, bearing the grinding material, except a firm and stiff mass, could have exercised the requisite pressure; and that it is only stiff masses which could have been driven forwards in directions sloping upwards, such as are exhibited locally by inclined grooves, the inclination of these sometimes amounting even to 20 degrees. But that the mass was also to a certain extent plastic, that is, yielding, or susceptible of change of form, may be inferred from the following additional considerations; namely, that the smoothing is continued over all the smaller inequalities of the surfaces, that it frequently sinks down into depressions, and rises over prominences, without being thus in any considerable degree disturbed, and that even rents and deep clefts in

the rock are smoothed out, though their width may be no more than two inches.

If we now collect all these propositions together in a few words, we obtain the result that, in one of the most recent geological periods, the surface of the land, when it had already obtained its present form, must have been very generally and very thickly covered with masses, which, bearing with them sand, and other matter composed of finely-comminuted stone, were urged forward, gradually and slowly, in the same direction; and which, besides, possessed a certain degree of plasticity, so that they could apply themselves to the contours of the hills which they embraced, and during their motion could, by their pressure, and with the aid of the interposed sand, smooth and grind away the rocky bottom.

If, now, concludes Naumann, we finally put the question, to what sort of masses, in the kingdom of nature known to us, such a motion and mode of operation can be ascribed? One answer alone can be given,—that masses of ice resembling glaciers are the only agents which appear capable of fulfilling the conditions which were required for producing the phenomena of Hohburg.

On Extracting Pure Gold from Alloys; and on the Discovery of Tellurium in Virginia. By C. T. JACKSON, U. S., G. S.

1. *A new method of extracting Pure Gold from Alloys and from Ores; by C. T. Jackson, U. S., G. S.*

The following method of obtaining pure metallic gold in the form of a spongy mass, has been practised by me for several years, and no account of the process has, to my knowledge, heretofore been published. It is very useful to the chemist and to the manufacturer, and is more economical than any other method that I am acquainted with.

After separating the gold from silver, by means of a mixture of nitric and chlorohydric acids, as is usually done, the solution containing gold and copper is to be evaporated to small bulk, and the excess of nitric acid is thus driven off.

A little oxalic acid is then added, and then a solution of carbonate of potash, sufficient to take up nearly all the gold in the state of

auriferous potash, is gradually added. A large quantity of crystallised oxalic acid is then added, so as to be in great excess, and the whole is to be quickly boiled. All the gold is immediately precipitated in the form of a beautiful yellow sponge, which is absolutely pure metallic gold. All the copper is taken up by the excess of oxalic acid, and may be washed out.

Boil the sponge in pure water so long as any trace of acidity remains, and the gold is then to be removed from the capsule, and dried on filtering paper. It may be pressed into rolls, bars, or thin sheets, by pressing it moderately in paper. I have made several useful applications of the gold sponge thus prepared, and had a tooth plugged with it in October 1846, to which purpose it is well adapted.

By moderate pressure, the spongy gold becomes a solid mass, and burnishes quite brilliantly.

The jeweller or goldsmith will find spongy gold to be quite convenient when he requires it for a solder, and it is a convenient form of the metal for making amalgam for fine gilding. I have used it for some years in soldering platina, and prefer it to the filings or gold foil for that purpose. This method of separating fine gold from coarse, is very simple, and cheaper than the usual processes. It is applicable in the separation of gold from ores that may be treated by acids, and is vastly preferable to the methods commonly used by chemists and assayers.

When making oxide of gold for dentists' use, the chemist will find that oxalic acid, added to his potassic solution, will at once recover all the gold that is dissolved in an excess of the alkaline solution.* Many other applications of this very simple method will occur to chemists and artisans.—(*American Journal of Science and Arts*, 2d Series, vol. vi., No. 17, September 1848, p. 187.)

2. *Discovery of Tellurium in Virginia; by C. T. Jackson, U.S. G.S.*

Early in May last, Mr Knowles Taylor of New York, gave me two specimens of native gold, in mica slate rock, from an auriferous vein recently discovered in Whitehall, near Fredericksburg, Va. In one of the specimens I observed a considerable mass of splendid foliated and sectile mineral of the colour of antimony, which I recognised as an ore of tellurium. The gold was imbedded in a mass of it, and it was also observed to exist disseminated through the rock in shining metallic leaves. On submitting this mineral to analysis, I discovered that it was a *telluret of lead and gold, or foliated tellurium ore*. In the open glass tube before the blow-pipe, telluric acid sublimes and condenses in the cooler part of the tube, in a yellowish white film, which melts into drops. A little greyish sublimate also deposits, which is metallic tellurium. The residual matter, cupelled

* Much gold is lost by the usual method of preparing the oxide.

on the mica, gave a well-characterised glass of litharge, and a minute globule of pure gold. This interesting mineral has not, I believe, been heretofore discovered in the United States, and it is extremely rare in Europe. It had been mistaken for sulphuret of molybdenum, and was considered to be of no value. That error should be corrected, for it is not only valuable as an extremely rare mineral, but since, as I am informed, it occurs in abundance in the Virginia mine, it should be saved and wrought for gold, in the same manner as is practised in the tellurium and gold mines of Transylvania. It is very easy to expel the tellurium by heat, and then the gold may be obtained by the usual processes of amalgamation by mercury, and discharge of the mercury by heat. Since I detected the tellurium, I have conversed with T. A. Dexton, Esq., of Boston, who has recently visited the mine, and has seen a considerable quantity of this tellurium ore in the vein. He gave me two very well characterised specimens, which he took from the vein in place; so there can be no doubt of its existence in a true auriferous vein.

I announced this discovery at the annual meeting of the American Academy of Arts and Sciences last month.—*American Journal of Science and Arts*, 2d Series, vol. vi., No. 17, September 1848, p. 188.

*Geological Observations made in Scotland, by Professor STU-
DER. Contained in a Letter to Professor LEONHARD.*

BEHN, April 25, 1848.

The views at which I have lately arrived with regard to the meaning of the cleavage of our gneiss and mica-slate hills, made it highly desirable for me to become more intimately acquainted with the researches of scientific men in Britain on this subject. Mr Sharpe, in London, by his collection of compressed specimens of *Spirifer* and *Productus*, was so kind as to confirm and illustrate to me the results already given in the *Jahrbuch*, to the effect that the distortion is the greater the smaller the angle is at which the direction of the cleavage cuts that of the stratification; and that all the compressions may be explained by a pressure perpendicular to the cleavage-planes, and an extension in the direction of their dip. With Darwin I had already discussed these matters in correspondence; and, during a short visit to him at his country-seat in Kent, our conversation fre-

quently reverted to the same subject. Both these geologists are inclined to attribute the cleavage of rocks, as Forbés does that of glacier ice, to a pressure applied at right angles to the planes of cleavage, and a contemporaneous motion which has existed in the direction of those planes; and the cause which they assign for the pressure is the protrusion of masses of rock from the interior of the earth. Sharpe, therefore, believes he can shew that the surfaces of cleavage form, over the axes of elevation, cylindrical arches, which are extended for great distances with much regularity, and are uninfluenced by the frequent contortions of the stratification; and also that, when two such arches intersect one another, the fan-like structure is produced, which the flanks of the arches are in many districts observed to possess. The rains, so frequent in the west of England, much to my regret, prevented me from obtaining more than a very superficial view of these phenomena, of which the importance, for our Alpine geology, is so great: yet I convinced myself completely of the reality and general occurrence of the distinction between the cleavage and the stratification which had previously been pointed out by Sedgwick in North Wales. In the extensive slate-quarries at Bangor, in which about 2500 workmen are employed, the cleavage is vertical, while the strata, about a fathom thick, lie almost horizontal. A similar structure is still more distinctly recognised in the neighbourhood of Capel Cerig. In another respect, also, did the slaty structure in Wales appear to me to differ from that which occurs in our mountains. The cleavage there is frequently not at all perceptible in the rock, and the splittings are obtained only by the hammer. On this account the stone is employed not merely for roofing, but also for sculptures and architectural ornaments, tombstones, chimney-pieces, and other objects. The structure, in fact, closely resembles that of a crystal. In our slates, on the other hand, the laminated divisions are always distinct; and the employment of the material for rounded sculptures, or for those of large size, would be impossible. The explanation of the fan-like structure, by the intersection of two cylindrical arches, can have no application in regard to the structure

of our crystalline-slate central masses; but on this subject it is unnecessary to say more than a few words. Mont Gott-
hard, the Bernese Alps, and Mont Blanc, are certainly not the still remaining centerings of former arches, which, if they had existed, must have extended over the entire space now covered with mountains of limestone and sandstone. Still, however, we may anticipate, from the farther investigation of these phenomena in England, much that would have an important bearing on the geology of the Alps; and, since the great Geological Survey of England, under the charge of De La Bèche, is just at the present time proceeding in Wales, the desired results will ere long be laid before the public. On the fan-like structure of the central masses in the Alps, as well as on many other matters connected with those mountains, we shall obtain a clear light, only when similar phenomena shall have been deciphered in regions presenting greater facilities for investigation.

In Scotland, my attention was, as may be supposed, particularly directed to the phenomena of the course and contact of eruptive rocks; and, under the skilful guidance of my friend Forbes, I saw, in a comparatively short time, most of the classic grounds on which modern science has fought out its most brilliant victories. What a multitude of important facts is afforded by the ground on which Edinburgh is built, and the country in its immediate vicinity; and how fully and variously is the inquirer instructed by men such as Jameson and Maclaren! In the Highlands of Perthshire we visited Glen Bruar and Glen Tilt, where, for the first time, Hutton discovered the penetration of granite veins into the superincumbent rock. The white marble, with serpentine veins, which appears lower down the river Tilt, and is an altered condition of the dark-grey limestone of that locality, reminded me vividly of Predazzo. Both places bear witness to the metamorphic origin of serpentine; and also in Wallis (Valais) and Piemont (Piedmont), where the serpentine in gneiss and mica-slate hills forms greater masses, it is usually found in close connexion with limestone and dolomite. Granites and porphyries rise up on a larger scale in the wild Glencoe, which leads from Kingshouse to Balahulish. He

indeed, there are really alpine mountains, such as do not often appear under the Scottish heaths: one might imagine himself in the Valley of the Albula, or in Val Vedro on the Simplon; and Kingshouse, standing solitary on the watershed, although scarcely 1000 feet above the sea, reminds the traveller from Switzerland of one of our mountain passes. This region is the principal scene of Ossian's poetry; and in summer it is resorted to by an almost uninterrupted succession of English tourists. Numerous red and white granites, syenites, and porphyries, here occur in close connexion; and, with the exception, perhaps, of Sassa, it would be difficult to find any region so well adapted for a very remunerating study of the questions which yet remain unsettled respecting these rocks and their mutual relations. Great dikes of red felspar-porphyry ascend vertically on both sides of the glen to the summits of the hills, and appear there to spread out over the chlorite slates which they intersect. Higher up the valley, the rock surrounding the red porphyry is of a black and reddish-brown colour, and resembles flinty-slate or jasper, but is still more similar to the black porphyries of the Lake of Lugano, and, like these, it contains nests and small veins of epidote, and small separate twin crystals of a kind of felspar, perhaps albite. The dense substance of the rock is with difficulty melted into a white glass. The rock is split vertically into plates, some of which are of small thickness, but it also shews traces of horizontal division; thus agreeing with the chlorite-slate situated lower in the valley, and with the gneiss at Kingshouse. It may perhaps be, not an eruptive rock, but a sedimentary one, altered in its present place and position by the red porphyry, as is assumed by Fournet to be the case with similar kinds of rock in South Tyrol. We are naturally led to compare, with the black rock and the red porphyry of Glencoe, the similarly-coloured rocks which form the mass of Ben-Nevis. The black porphyry of this highest peak of the Scottish mountains, is richer in felspar than that of Glencoe. I have not observed epidote in it. The division into plates, and the tendency to the character of jasper, are wanting; yet identical modifications might easily be obtained from both places; and the rock of Ben-Nevis exhibits the

same bright grey, rough, and corroded, superficial crust, produced by weathering, which is so striking in the porphyry of Glencoe. There appears also on its outer surface a brecciated structure, which gives it a deceptive resemblance to a sedimentary rock; although, when freshly quarried, it has the appearance of a homogeneous mass. Greater still is the similarity of the red rocks of both localities. The granite of Ben-Nevis passes into a red porphyry so like that of Glencoe, that I could not distinguish the one from the other. In Glencoe, likewise, the intimate connexion of the granites in the bottom of the valley, and in the vicinity of Kings-house, with the porphyry which rises in dikes, can scarcely be doubted. This constant association of trap-like porphyries,—black, and poor in quartz,—with red granites and porphyries, is a remarkable fact. We find this association not merely in Scotland, for it occurs also in Thuringia, in the Palatinate, in Provence, and in the long zone of porphyritic hills which run along the southern border of the Alps, from Piemont to Stiermark. How vividly does Ben-Nevis remind one of Monte Mulatto, at the mouth of the Fassa Valley, where also red granite forms the basis, and black porphyry the upper mass of the mountain!—Willingly would I have investigated these relations farther, but the important trap islands of the western coast lay before us; and although steamboats and railways now afford great facilities, yet, with the deduction of Sundays and rainy days, we had already but too little time remaining to devote to these fortresses of our science. With regard to the facilities for travelling to which I have just adverted, I may mention, that on one beautiful day, we proceeded from Fort-William round the Isle of Mull to Oban, having stopped on the way for some time at Staffa and Iona; and on another day we went from Arran to Edinburgh. The flying view which we thus obtained, served to strengthen the conviction that, for the development and completion of the detail of the new doctrines respecting granite and trap, a more favourable ground could scarcely be obtained than that which is afforded by Scotland and its islands.

In this country one is incited also, in a peculiar degree, to

studies respecting another and entirely different part of our science, by the numerous traces of alterations of the surface, which have occurred during the most recent geological times. The extraordinarily broken lines of coast—the cutting off, at the sea coasts, of the formations which extend obliquely across the island—the isolated occurrence at the shores of limited masses of formations which, in other places, are widely extended, all indicate great changes of level, to which testimony is also borne by terraces, in some instances remarkably well preserved, occurring both on the coasts and in the interior. The great thickness and extension of the *Till*, together with the occurrence of erratic mounds of earth and heaps of stones in all the valleys, point to currents, for the origin of which, unless they were currents of the sea, space would appear to be wanting. In many places, finally, polished and rounded, or furrowed and scratched rocks, have been observed of the same kind as those which occur among the Alps and in their neighbourhood; and from them the former occurrence of glaciers in this country has been inferred. Many questions relating to these phenomena are, as yet, involved in doubt; and it would be presumptuous for me to attempt to decide in regard to matters which, by native geologists, after much careful investigation, have been left undetermined. To the assumption of former glaciers, I feel quite favourably disposed; although it appears difficult to believe in so unlimited an extension of them as must be assumed in this case, as well as in many others, if we attribute the whole phenomena of erratics to this agency. Many of the higher hills exhibit, in various places on their flanks, that peculiar elevated background, widened out into a cauldron shape, which in the Alps serves as the chief source of the glaciers. Instances of this kind are met with in Glen Nevis, in Glencoe, on Goatfell in Arran, and in Capel Cerig in Wales. In Glencoe, also, Forbes directed my attention to smoothed rock surfaces, and rounded prominences of the black porphyry, which was formerly mentioned, and was stated to be split into plates. These were undistinguishable from similar phenomena in the neighbourhood of our glaciers. On the west side of Salisbury Crags at Edinburgh, two smoothed rock-sur-

faces have been disclosed by recent road-making operations, of which one is distinctly a natural parting of the stone, or an internal surface caused by sliding; but the other of them, which is covered with furrows and scratches, agrees precisely with our smoothed surfaces produced by the sliding of glaciers. But where should we seek for any source from which glaciers could have spread themselves to this locality, their motion being due to the force of gravity? The Grampians—the nearest mountains of any considerable height—have, with reference to this place, an angular elevation of only about half a degree; while those glaciers, at present known, which approach most nearly to horizontality,* have a slope of about three degrees. From Solothurn, where ancient erratics from Wallis are to be found, to the summit of the Alps at the Great St Bernard, we obtain a slope amounting to $1\frac{1}{2}^{\circ}$; and how small does the portion of the Scottish Highlands appear, which, under altered climatic relations, might have been capable of supplying glaciers, when it is brought into comparison with the regions of the Alps. Similar difficulties, it appears to me, militate against the ingenious hypothesis of Agassiz, that, by means of a glacier proceeding from Ben-Nevis, the water in Glen Roy, to which the celebrated Parallel Roads are attributed as beaches, has been confined. It is not the requisite fall, however, but a sufficiently extensive plateau which, in this case, is wanting. On account of such objections as have just been stated, it is natural to expect that there should be, as there actually are, in Great Britain and Scandinavia, many and eminent adherents to the explanation of the diluvial and erratic phenomena, by means of the rising of the

* In Mr Thomson's paper on the Parallel Roads of Lochaber, published in the Edinburgh New Philosophical Journal for July 1848, in paragraphs 13 and 14 of the paper he points out what appears to him to be quite a satisfactory explanation of the fact, that the present Swiss glaciers do not spread much over the low level land, and explains the peculiar state of the climate of Scotland, which he conceives would occasion the glacier, whose former existence in this country is indicated by such facts as those adduced in the letter of Professor Studer. Mr Thomson thinks much misconception, regarding the possible existence of glaciers, under various circumstances, has arisen from a too exclusive study of those at present met with in Switzerland.

land out of the sea,—an explanation which has been developed with remarkable ingenuity by Darwin for South America, and more recently by Sartorius von Waltershausen for Iceland.* In those countries which have emerged from the sea, people are readily inclined to ascribe all traces of former erosion and destruction to the contiguous element, whose contests with the solid land are testified by daily experience; while in Switzerland, on the other hand, situated as it is in the interior of the Continent, we seek aid from those agencies which produce the grandest effects in our experience. Proof, however, is certainly as yet wanting, that the retiring sea, or the friction of coast-ice, can produce phenomena of erosion similar to those which are due to the slow motion of glacier-ice. Willingly would I aid in attributing to the waves of the sea the origin of our great Molasse valleys, and the covering of their bottoms with thick deposits of gravel and other materials, if I could but satisfy myself with the assertion of Darwin, that the preservation of marine organic remains is only an exceptional case, and that their absence, even in widely-extended formations, is not to be adduced as an argument against the marine origin of these formations. In the meantime, it may perhaps be possible to bring into agreement for the explanation of our Swiss phenomena both principles—those, namely, of marine erosion, and of the deposition of gravel by mountain streams; for I have long felt convinced, that considerable changes, like those which are at present taking place in Sweden,—that is, elevations without disturbance of the horizontal position of the beds,—have occurred in Switzerland and its vicinity, at a period subsequent to the deposition of our gravel.

* *Vide* Edinburgh New Philosophical Journal, vol. xlv., for Waltershausen's Observations.

On the Formation of Coal.

Among the various subjects considered by geology, few are of more general interest than the origin of those vast stores of fossil fuel found in the coal-fields of our own and other countries. That this coal is nothing more than vegetable matter, which has undergone a certain mineralising process, is now generally admitted, and may be very readily proved by placing some ashes from a fire under the microscope, when the remains of tubes and fibres will generally be detected, though of course the great mass of the vegetable structure has perished during combustion. When we now consider the thousands of square miles covered by beds of coal, measuring many yards in thickness, and several times repeated, and take into account the fact that, in the temperate zone, the accumulated growth of a forest in a hundred years would not, if converted into coal, cover the ground on which it stands much above half an inch thick, we may well wonder how such enormous masses of fossil fuel have ever been produced. If a forest only forms some six or seventeenths of an inch thick of coal in a century, when, it may well be asked, would it form a bed of ten, twelve, or twenty feet in thickness, still more the many beds piled up one above the other that are seen in all the coal-fields round this city?

It is not surprising that this difficulty should have driven geologists into many strange theories to account for the origin of coal beds,—that some should have recourse to forests growing over vast continents, and swept by the Amazons or Mississippis of the antediluvian world into lakes or gulfs, where the vegetable spoil was collected during long ages, and gradually mineralised by various subterranean processes,—that others should imagine some wholly unknown conditions of climate, and atmosphere loaded with superabundant stores of carbonic gas, and raised to more than tropical heat by its proximity to the molten nucleus of the new-formed globe. We shall not now discuss the merits of these or other theories, thinking it will prove more acceptable to our readers should we glean for their use a few of the more important facts con-

tained in a memoir, "On the Vegetation of the Carboniferous Period as compared with that of the present day," which has just appeared in the last volume of the "Memoirs of the Geological Survey of Great Britain;" and in the pages of Jameson's Edinburgh New Philosophical Journal. The author of this interesting paper is Dr Hooker, botanist to the Geological Survey, who, having accompanied Sir John Ross in his voyage towards the South Pole, had an excellent opportunity of observing vegetable life in those Antarctic regions, which are usually thought to present the closest resemblance in existing nature, to those conditions of climate, and of the distribution of land and water, which prevailed at the time when the coal plants flourished in the northern hemisphere.

It is often thought that the kind of vegetation entombed in the coal formation, independent even of its amount, furnishes strong evidence of a climate different from that now existing. Dr Hooker, however, remarks, that we can never hope to arrive at great precision in determining the species of vegetable remains; and that we have still less reason to expect that they will prove equally appreciable indices with the remains of animals, of the climate and other physical features of that portion of the surface of the globe upon which they formerly grew. Fossil botany has also great difficulties to contend with, in the fragmentary condition of the remains and in the vast extent of the existing vegetable world, which must be so far mastered before any one can venture on the study of the remains of ancient floras preserved in the rocks. In the coal formation, however, these remains are presented in vast profusion and in a great variety of states—some preserved in shales, others in ironstone, others, again, in sandstone; some with only the outline of their external form, others with their most delicate internal tissues in a condition fit for microscopical examination, and thus much facilitate their study. The novelty of the forms, too, whilst it adds to the difficulty of the study, increases also its interest, and the botanist, in descending through a few yards in the shaft of a coal-pit, finds himself transported to a world far more distinct from that he left above ground, than a voyage of many thousand miles would produce.

The plants found in our coal fields belong to only a few of the great orders of vegetables now existing on the globe. The most numerous group is the ferns, which also rank lowest in the scale, none of the inferior orders—mosses, lichens, or fungi—having yet been observed. The highest well-ascertained group is the Coniferæ, or plants bearing cones like our present firs or pines, to which the magnificent fossil stems seen, exposed in Granton and Craigleith quarries, are referred. The class to which the Sigillariæ, known by the seal-like impressions on their stems, belong, is, however, still undecided, some placing them among ferns, others among the Coniferæ, others in an intermediate group, and a fourth even higher still among the Euphorbiæ or Cacti, natives of the arid desert regions of the tropics. These various plants seem to have had a far wider geographical distribution than the similar plants in the present day, showing a uniformity of vegetation in the northern hemisphere to which no parallel now exists. Even in Melville Island,* deep in the Arctic regions, plants identical with those in the coal formation of Britain are said to have been found, though no explanation has yet been given how plants of such size and so singularly succulent and lax in their texture could have flourished in these dreary regions, or endured the continual frosts and the prolonged withdrawal of the stimulus of light.

The under-clay or soil on which the coal rests, seldom contains any plants except the stigmariæ, now considered to be the roots of the sigillariæ which permeate its mass, as those of the water-lily and other aquatic plants do the silt at the bottom of still waters. This shows that this clay was either submerged or otherwise unfit for supporting vegetation. Above this is the coal, formed of the detritus of these plants, and probably of others drifted from other places, though the extreme rarity or entire absence of sand or pebbles in the coal beds is opposed to the idea that much of it can have been brought from a distance by running water.

* We have specimens of Melville Island coal plants in our possession, and fossils of the same description from Neill's Cliffs in Jameson's Land—a tract of country in a high northern latitude on the east coast of Greenland.—Edit.

Next follows the shales, resembling a quiet deposit from water, but bearing evidence of the existence of a vigorous vegetation, in the numerous ferns and other plants imbedded in them, and often resembling in beauty of outline, recent specimens spread out on the pages of a well-kept herbarium. Along with these are in many cases innumerable stumps of *Sigillariæ*, usually in an erect position, and spread over the surface of the coal below, like the remnants of an ancient forest in one of our peat mosses. This seems to prove that these trees have grown in the coal, and it is a remarkable confirmation of this opinion, that their roots, or the *stigmariæ*, are very rare in the shales, having probably been fixed in the coal and mineralised with it. Along with the shale are found seams and nodules of ironstone, either a deposit from water charged with iron and soil, or more probably a segregation of mineral matter from the mass of clays, round broken bits of vegetables or other organic bodies. It thus resembles the nodules of bog-iron-ore, forming in many mosses in the present day.

In the coal formation of Great Britain about three hundred species of plants have been enumerated. Many of these are mere fragments, probably portions of one plant, and, though many new species may still be discovered, yet the number of real species will perhaps rather be diminished than increased by the future progress of science. These remains indicate a most luxuriant vegetation, but it by no means follows that it was also a varied one. In a forest we often find a very few trees covering a vast area, to the entire exclusion of all others, and so in the forests of the carboniferous epoch a few *Sigillariæ* and *Lepidodendrons* may have sheltered a limited number of ferns, with no great diversity of other plants. The analogy of existing nature would rather confirm this view, as we see the common bracken in our own country, and a species of the same genus (*Pteris esculenta*) in Van Diemen's Land and New Zealand, monopolising the whole soil, and excluding all other plants over wide areas. Ferns, too, indicate a uniform climate, unfavourable to a variety of flowering plants; and *Tasmania*, barely 200 miles long, contains

four times as many species of flowering plants as New Zealand, whose total length is 900 miles. Yet in the latter Dr Hooker has collected as many as 36 kinds of fern in an area not exceeding a few acres, to whose vegetation, which presented scarcely a dozen flowering plants and trees besides, they gave a most luxuriant aspect. An equal area in the neighbourhood of Sydney, in about the same latitude, would have yielded upwards of an hundred flowering plants and but two or three ferns. New Zealand possesses more than four times as many ferns as Tasmania, and the same species that are found at its southern extremity, prevail also at the northern, and extend even to the Society and Sandwich Islands. On the other hand, the campos of Brazil, the sandy flats of Southern Africa, and the similar plains of Australia, though apparently sterile, yet abound in flowering plants, but unaccompanied with ferns. Hence the abundant remains of the latter in the coal formation, seem to prove that the climate then was temperate, equable, and humid, and the land covered with a dense vegetation, uniform in aspect and distinguished by its general poverty in varied forms. In the coal formation of Great Britain no fewer than 140 species of fossil ferns have been enumerated, whereas in its present flora only fifty are known to exist, and it is doubtful whether all the fronds or fern leaves now in Great Britain would equal in number those contained in the largest seams of coal. Such a predominance of ferns is only found in the tropics, or in the equable moist climates of the southern hemisphere. Had the climate of Britain, either from the escape of central heat, or an alteration in the position of the poles, resembled that of the tropics, it seems probable that the number of flowering plants fossilised with the ferns would have been increased; and hence the supposition is more probable that this character of the vegetation rather arose from the more uniform nature of the seasons, with no increase of mean temperature. And this uniform temperature seems to have prevailed over the whole northern hemisphere, as of the British coal ferns about fifty are found in the carboniferous beds of North America, and *as many* in those of the continent of Europe.

These observations of Dr Hooker rather, however, point out the difficulties of explaining the origin of coal than remove them ; but are of great importance in showing that some theories often proposed are not applicable, and thus turning speculation into the right path. The climate of the coal period has not been tropical, and this truth which the shells preserved in the shales and limestones might long ago have taught, is now confirmed also by the plants. It is not, therefore, in internal heat, or in changes in the earth's axis of rotation, that we have to look for the cause of our coal beds. Rather, we suspect, will this be found in formations like our actual peat mosses, and in a vegetation like that which now flourishes on them, but of a larger size and more rapid growth. And perhaps the difference in rapidity of growth would be less than many think. Every moorland farmer knows how soon the portions of peat cut out for fuel are replaced by new moss, though we do not remember to have seen any precise statement of the annual rate of increase. We have little doubt that were this ascertained, the amount of vegetable matter accumulated on an acre of surface by the despised *Sphagnum* and its humble associates, would be found far to surpass that produced in the same time by an equal extent of ground covered by the stately oak or the lofty pine.

When lately travelling across the Solway Moss by the Caledonian Railway, we could not avoid feeling that in that place we had before us some chapters in the history of a coal formation, repeated in modern times. In the shallow cuttings on the side of the line we see the undersoil of sand and gravel, which may represent the sand-stones and conglomerates of the ancient deposit. Then comes a thin bed of soil—a shale or underclay—with roots of trees traversing it in all directions. Next is the modern coal, a thick bed of peat, full of remains of trees—sometimes the whole stems prostrate along the ground—sometimes the mere stumps still standing erect in the place where they once flourished. Then often, above all, we have another bed of shale, or clay and vegetable soil. The surface, too, is as level as a coal deposit; and very slightly elevated above the neighbouring Solway Frith. Sink it but a few yards, and we might have the whole covered with

another layer of sand, on which silt, and moss, and soil, might again accumulate. The old country rhyme tells us it was

“ First a wood, and then a sea,
Now a moss and aye will be.”

But geology goes a step further back, and points to the proofs that it was a sea before it was a forest ; and modern improvement threatens soon to prove its prophecy in the last line also false, by turning the waste moss into fertile corn fields. —(*W. Nicol, in Scotsman.*)

SCIENTIFIC INTELLIGENCE.

GEOLOGY.

1. *On Glaciers.*—M. Grange has sent a memoir to the Academy of Sciences, entitled, “ Researches on the Meteorological and Orographical Causes which have made the extent of Glaciers to vary in historical and geological times ; being a comparative study of the Erratic Deposits of the north of Europe and the southern parts of South America.”

In this work the author has endeavoured to shew precisely the degree of the influence of climates on the development and extent of glaciers. He particularly points out the considerable difference which subsists in this respect between the marine and continental climates of temperate latitudes. He concludes, from his own observations and those of others, that every important change in the extent of continents, whether proceeding from immersion or elevation of the land, must bring on a proportional modification in the extent and thickness of the glaciers.

In a previous memoir presented to the Academy, and published in 1846, he had shewn that we may explain the erratic deposit of the north of Europe, and the grooving of the rocks, by the immersion of the plains in which this formation occurs, an immersion which had been followed by the extension of the glaciers ; and that the complex characters resulting from this great geological event might be referred either to the existence of glaciers and floating ice, or the currents formed by the waters in the deep bottom of this sea. In the memoir now presented, which is a succinct view of a much more considerable work soon to be published, he shews that the characters of the erratic deposit of the south of South America are identical with those of the north of Europe, and that, in America, it was

quite impossible not to perceive that the erratic deposit had been formed in the bosom of the sea at a period when glaciers of great size existed on the great islands and peninsulas formed by the chains of the South American mountains. In support of his opinion, M. Grange observed, that, in the present day, a considerable erratic deposit is now forming in South America, in the same circumstances, and by the same agents, as in the anterior epoch; the extent and power of the agents alone being diminished.—(*L'Institut*, No. 772, p. 318.)

2. *The probable cause of Goitre and Cretinism.*—A memoir which M. Grange presented at the same meeting, contains the results of numerous analyses of waters from the talcose, anthraxiferous, and cretaceous formations of the Valley of the Isère. These analyses have led the author to some interesting results on the relative quantity of the chlorures, sulphates, and carbonates, found in the waters of different geological periods, and at different heights. Among others, he has made the observation, that the waters of all the villages and valleys in which goitre and cretinism are endemic, contain a considerable quantity of the salts of magnesia, from whatsoever formations the waters flow. We shall give a few details.

The investigation was made among the mountains which inclose the great Valley of the Isère, mountains which belong, some of them to the system of the Western Alps, attaining the height of 3000 metres; others to the cretaceous and neocomian formations, whose elevation is much less considerable. The author's object in undertaking the task, under the direction of M. Dumas, was to find out the relative quantity of chlorures, sulphates, and carbonates, contained in the waters, from the glaciers down to the plain, and to compare the salts dissolved in the waters of the granitoid or talcose formation with those of the anthraxiferous and cretaceous formations, with a view to determine their absolute and relative quantities.

The analyses have been made, generally, on 20 litres, and the results referred to 1 litre; so that the numbers express the absolute weight of the salt and a fraction of a kilogramme of the water analysed.

The waters of the glacier of Glezin, obtained in the glacier itself, at a height of 2259 metres, contain carbonic acid, oxygen, and azote in solution, like all running waters, taking into account the small pressure to which they are subjected. The evaporation of these waters gave a small quantity of salts, in which chlorures and sulphates predominate.

A comparative examination of the tables of analyses accompanying the Memoir, shews, 1st, That the quantity of dissolved salts goes on increasing from the summit of the mountains towards the plain; 2d, That in the talcose and anthraxiferous formations, the

chlorures of soda and magnesia, the sulphates of soda, lime, magnesia and potassa, diminish relatively to the total mass of the salts as we descend from the summits, and form nearly from 25 to 30 in the 100 of the dissolved salts; the sulphates from 24 to 31 in the 100; the carbonates from 36 to 47 in the 100; 3d, That in the anthraxiferous formations, the sulphates of soda, lime, and magnesia, exist in greater absolute quantities than in the talcose formations, and represent from 18 to 37 in the 100. This proportion of sulphates is explained by the nature of this formation, composed as it is of sandstones and argillo-calcareous slates, very rich in pyrites, gypsums, and dolomites; the chlorures do not here exceed from 10 to 16 in the 100; 4th, That in the cretaceous formations, the chlorures and sulphates diminish considerably, to the gain of the carbonate of lime and carbonate of magnesia, in the waters which flow over the dolomitic limestones. M. Grange makes the following remarks on this subject:—

“It appears to me that these results ought to be of interest, not only to chemists and geologists, but also to physiologists, physicians, and agriculturists.

“It is now an opinion generally established, that our household waters perform an important part in nutrition, by furnishing substances necessary to the wants of the economy, and that the latter does not always find a sufficient quantity of them in the ordinary aliments; such is the case with the carbonate of lime. But these waters may contain, sometimes useful mineral principles, at other times deleterious ones, and it is to these deleterious principles that the people themselves, and observers, ascribe the development of goitre, cretinism, and rachitism.”

“I have given a rapid sketch, in my work, of the opinions expressed as to the probable cause of goitre and rachitism, and have shewn that none of these theories can explain the facts. My analysis having indicated the presence of a considerable quantity of magnesia, from 10 to 15 in the 100 of the total amount of salts, in all the waters of the villages and valleys where goitre and cretinism are endemic; and observing that these analyses, made in three different formations,—the talcose, anthraxiferous, and cretaceous,—may explain the development of the endemic affections by the presence of the salts of magnesia, I have carefully inquired whether magnesia rocks existed in the High Alps, Switzerland, Piedmont, the Vosges, Pyrenees, and in all other places where these maladies prevailed; and, in fact, talcose, gypseous or dolomitic rocks, and ophites, were to be found wherever goitres or cretins appeared. M. Elie de Beaumont, in his *Memoirs*, so rich in geological observations, brings forward many facts which support my opinion. M. Boussingault also states, that he collected a series of gypseous or dolomitic rocks in the provinces of the Andes, where he observed goitres. M. Darwin, in his work on South America, is so struck with the

enormous masses of gypsum and dolomite met with among the Andes, that he has formed a theory to account for their presence.

"It follows, then, from the analyses and geological observations I have made, that if the waters be, as is generally believed, the proximate cause of goitre and cretinism, we may refer the deleterious action of the waters to the salts of magnesia, or, perhaps, to the presence of the magnesia, and the absence, at the same time, of a quantity of lime sufficient for the wants of the economy. Analysis is required to solve this problem.

"I have pointed out a preservative means in my Memoir. This consists in separating the magnesia, by making the water pass through filters, or into large reservoirs filled with carbonate of lime, and a thin layer of lime."—(*L'Institut*, No. 772, p. 319.)

MINERALOGY.

3. *Cause of Irised Colours on Minerals.*—From M. Hausmann's valuable Memoir, sent to us, on this branch of optical mineralogy, we gather that the irised colours on minerals, like that on steel, are due to a thin film covering the surface; and that the colours are varied by a variation in the thickness of this film. It is often produced by a chemical change in the surface of the mineral, and sometimes by deposition of a foreign substance. Hydrated oxide of iron is one of the most common of the substances that communicate irised hues. This compound results from the decomposition of pyrites either forming first a carbonate which is common in many waters, and then by the evaporation of the water yielding the hydrate, or forming the hydrate direct. The colours on anthracite and specular iron often proceed from this source; and an exposure of the latter species to water containing the carbonate, afforded Hausmann, after a while, irised specimens.

Arsenic becomes irised through the action of hydrogen from the atmosphere; *bismuth*, by a superficial oxidation; *arsenical cobalt*, *nickel*, and *iron*, by oxidation; *galena*, probably from the formation of a thin coating of sulphate of lead; magnetic iron, and some ferruginous silicates (as olivine, yenite, &c.), from a change in the oxide of iron to a hydrate; *pyrites*, from the formation of a hydrate of iron; *copper pyrites* and *variegated pyrites*, probably from the same, the latter being very remarkable for the rapidity with which the change takes place in a moist atmosphere; *antimony glance*, and other antimony ores, from the formation of antimony ochre; *fahlerz*, and other arsenical ores, probably from the oxidation of the arsenic.

These irised colours sometimes proceed from the absorption of oxygen and the elimination of water, or from a disengagement of carbonic acid with a loss of water, as in spathic iron and carbonate of manganese.

Irisation is often favoured by heating, as in the case of steel.

4. *Emery in Asia Minor.*—M. Tchihatcheff, in his recent explorations in Asia Minor, has discovered extensive beds of emery in the western portions of this country, particularly between the ruins of Stratonicea in Caria and Smyrna.

5. *Gold in Canada.*—I have had an opportunity lately of seeing the masses of gold found in the valley of the Chaudiere. Mr Charles De Lèry, the proprietor of the seigniory on which the precious metal is found, shewed me the original mass, first found in 1833, of which mention is made by Lieut. Baddeley of the Royal Engineers. Its weight is about 1052 grains troy. Other masses of equal weight have also been found in the bed of the same stream. The weight and density of these were taken, which were respectively,—

	Grains.	Grammes.	Density.
Weight, .	73·24	7·022	16·00
... .	742·16	48·095	15·54
... .	1058·56	68·598	12·86

Numerous smaller masses have also been found. The density indicates the presence of silver in the gold, which the faint colour also confirms. The analysis of a fragment by Mr Hunt gave 13·67 per cent. silver. The less density of the larger mass was owing, doubtless, to foreign matter mechanically entangled, as well as to interstices filled with air. The lumps are worn smooth, as is usual in alluvial gold; but fragments of quartzose gangue could still be detected in some of them. Mr De Lèry informs me that they were firmly imbedded in what appeared to him to be slate, but which is probably a concrete of detritus, cemented by oxide of iron. Chromic iron, titaniferous iron, serpentine, spinel, rutile, and talcose rocks, remind us very strongly of the mineralogical characters of the Russian gold regions, and their occurrence with the gold in Canada certainly affords favourable grounds for the hope that this may become a rich auriferous region.

As yet no excavations have been made on any scale of magnitude sufficient to warrant an opinion of the actual wealth of the deposit. A few tons of gravel have, however, been washed in a rude way with the Berks rocker, which have yielded about \$4 of gold to the ton of gravel.—(*American Journal of Science and Arts*, Second Series, vol. vi., No. 17, p. 274.)

6. *Produce of Gold in the Ural and Siberia in the year 1846.*—According to a notice in the "Kommertscheskaja Gaset," or Russian Commercial Journal, published by the Ministry of Finance, in February 1847, there had been remitted to the mint at St Petersburg 1397·378 poods of gold, the produce of the imperial and private mines in the Ural and Siberia during the year 1846. There was still expected 325·363 poods of gold, the produce of these mines in that year.

The total produce, therefore, of Russian gold in 1846 was 1722·746 poods, or about 62·792 lb. avoirdupois; whilst, in the previous year (1845) it was only 1371·800 poods, or 49·522 lb. avoirdupois. The annual increase which had fallen in the last two years to 47 and 30 poods, has consequently risen to 351 poods, or 12·670 lb. avoirdupois, which much surpasses any previous increase; the largest formerly, or that between 1842 and 1843, being only 323·80 poods.—(*American Journal of Science and Arts*, Second Series, vol. vi., p. 275.)

7. *Dimorphism of Zinc* (Jour. Pharm. et Chem., xiii. 18).—Noeggarath has described (*Annales de Pogg.*, xxxix., 324) crystals of pure zinc, of the form of hexagonal prisms. J. Nicklès reports that a specimen of zinc, prepared by M. Favre after Jacquelin's process, was crystallized in pentagonal dodecahedrons, like those of pyrites and grey cobalt. Zinc is therefore dimorphous. This is not the only example of dimorphism among metals. Miller has shewn that tin crystallizes in square prisms (dimetric system), and Frankenheim has observed it in cubes. G. Rosè (*Annales de Pogg.*, xlv., 319) has announced that palladium and iridium are isodimorphous, crystallizing both in the rhombohedral and tesseral systems.—(*American Journal of Science and Arts*, Second Series, vol. vi., No. 17, p. 255.)

CHEMISTRY.

8. *Chemist to the Royal Highland and Agricultural Society*.—We have pleasure in announcing that our accomplished young friend, Dr Thomas Anderson of Leith—an élève of Berzelius and Liebig, author of *Memoirs on Organic and Inorganic Chemistry*, has been appointed to the lucrative office of Chemist to the Royal Highland and Agricultural Society of Scotland.

9. *Purifying Liquids by Galvanism* (Patent Office Rep., issued in 1848, p. 41).—A patent has been granted for an interesting process by which a feeble galvanic power is employed to separate salts, acids, or alkalis from water or other liquids. Two porous vessels containing water are partly immersed in the liquid to be purified, and a zinc plate placed in one vessel, and an iron plate in the other vessel. Other metals would answer, but the inventor prefers the above. The zinc and copper plate being connected by a wire, galvanic action is established, and the salts and other soluble matters are carried through into the porous cups, and these accumulate in one or the other, according to electrical relations of the impurities.—(*American Journal of Science and Arts*, Second Series, vol. vi., No. 17, p. 260.)

10. *On the Radiating Power of Substances*. By A. Masson and L. Courtépée (*Comptes Rendus*, December 20, 1847.) In the ex-

periments of Masson and Courtépée, the substances, pulverized with some water, holding a little glue in solution, were applied in coats to the faces of a small cube of copper. This cube filled with boiling water was placed before a thermo-electric pile, with the radiating surfaces perpendicular to its axis. They concluded that,

(1.) The metals have a much greater radiating power when in grains than when melted, or in mass.

(2.) That the radiating power of a substance depends on the cohesion of its parts, and not upon their nature.

(3.) That, if all bodies were reduced to the same degree of chemical subdivision, they would have at 100° C. the same radiating power.

11. *Analysis of the Ashes of Turnip Leaves.*—M. Namur states that, deducting accidental admixtures, the leaves of the turnip (*Brassica rufo*, L.) yielded 0.39 per cent. of ashes, consisting of

Silica,	.	.	.	.	6.144
Sulphuric Acid,	.	.	.	.	4.003
Phosphate of Iron,	.	.	.	.	1.332
Magnesia,	.	.	.	.	7.447
Potash,	.	.	.	.	29.529
Soda,	.	.	.	.	2.107
Phosphoric Acid,	.	.	.	.	1.176
Chloride of Sodium,	.	.	.	.	3.251
Lime,	.	.	.	.	25.510
Carbonic Acid,	.	.	.	.	19.501

100.000

—*Journ. de Pharm. et de Ch.*, Janvier 1848.—(*The London, Edinburgh, and Dublin Philosophical Magazine*, Third Series, vol. xxxiii., No. 219, July 1848, p. 78.)

12. *On the Inorganic Substances in the different Parts of Plants.* By D. C. Rammelsberg (*Poggendorff's Annalen*).—The examination of pease and rape shewed a remarkable difference between the arrangement of the inorganic constituents of the seeds and the straw. In these plants, the seeds contained potash, without a trace of soda; the straw contained both alkalies, but most of the soda. Lime and magnesia are present in all parts of both plants,—the former predominates in the straw, the latter in the seed. Phosphoric acid, which forms nearly half of the ash of the seed, is found only in small quantity in the seeds; the carbonic acid of the ash, derived from organic acids, &c., varies in a similar manner.

The analyses of several other seeds, &c., quoted by Rammelsberg, seem to agree tolerably well with the supposition that potash predominates in the seed—soda in the straw or wood; this is certainly not a universal rule. The large quantity of phosphoric acid in seeds has been noticed by other authors.

ARTS.

13. *On Auriferous Glass.* By H. Rose.—Gold is well known to be used in making a beautiful red glass. After fusion this glass is colourless; but when heated not above a red heat, it becomes of a bright-red colour. Rose suggests that the gold is contained in the glass in the state of a protoxide, which forms a colourless silicate by fusion, but sets free some portion of the protoxide when re-heated to a temperature a little below that which forms it. This protoxide disseminated in a small quantity, in an extreme state of subdivision, is believed to give the red colour. When too much heated, the red changes to a brown, and Rose attributes this to the oxide of gold becoming partly reduced, and metallic gold set free. A fact, according to Rose, confirming this view, is presented by copper. For a glass containing the protoxide of copper is colourless after fusion, a silicate being formed; but it becomes green after heating, owing to the oxide set free. The ingredients used for the auriferous glass are, forty-six pounds of quartz, twelve of borax, twelve of nitre, one of minium, and one of arsenous acid; these are moistened with a solution of eight ducats of gold, in aqua regia, and then fused.—*Poggendorf, Annal.*, vol. lxxvii., p. 556.)

14. *On a Peculiar Property of Coke.* By Mr J. Nasmyth.—The following interesting fact was discovered some years ago, and it appears to furnish additional evidence as to the identity of the diamond with carbon; namely, that coke is possessed of one of the most remarkable properties of the diamond, in so far as it has the property of *cutting glass*. I use the term “cutting” with all due consideration, in contradistinction to the property of scratching, which is possessed by all bodies that are harder than glass. The cut produced by coke is a perfect clear diamond-like cut, so clean and perfect as to exhibit the most beautiful prismatic colours, owing to the perfection of the incision. Coke hitherto has been considered as a soft substance, doubtless from the ease with which a mass of it can be crushed and pulverised; but it will be found that the minute plate-formed crystals, of which a mass of coke is composed, are *very hard*, and, as before said, are possessed of the remarkable property of *cutting glass*. This discovery of the extreme “diamond-like” hardness of the particles of coke will, no doubt, prove of value in many processes in the arts, as well as interesting in a purely scientific sense. In a conversation which ensued, it was stated by Mr Chance of Birmingham, that, in all probability, the knowledge of this fact would lead to a saving of nearly £400 a-year, in their establishment alone.

15. *On the Chemical Character of Steel.* By Mr Nasmyth.—Were we to assume, as our standard of the importance of any investigation, the relation which the subject of it bears to the progress of civilisation, there is no one which would reach higher than that which refers to the subject of steel; seeing that it is to our possession of

the art of producing that inestimable material, that we owe nearly the whole of the arts. I am desirous of contributing a few ideas on the subject, with a view to our arriving at more distinct knowledge as to what (in a chemical sense) steel is, and so long the true basis for improvement in the process of its manufacture. It may be proper to name that steel is formed by surrounding bars of wrought iron with charcoal, placed in fire-brick troughs, from which air is excluded, and keeping the iron bars and charcoal in contact, and at a full red heat for several days, at the end of which time the iron bars are found to be converted into steel. What is the nature of the change which the iron has undergone we have no certain knowledge; the ordinary explanation is, that the iron has absorbed and combined with a portion of the charcoal or carbon, and has, in consequence, been converted into a carbonate of iron. But it has ever been a mystery that, on analysis, so very minute and questionable a portion of carbon is exhibited. It appears that the grand error in the above view of the subject, consists in our not duly understanding the nature of the change which carbon undergoes in its combination with iron in the formation of steel. Those who are familiar with the process of the conversion of iron into steel, must have observed the remarkable change in the outward aspect of the bars of iron after their conversion; namely, that they are covered with blisters. These blisters indicate the evolution of a very elastic gas, which is set free from the carbon in the act of its combination with the iron. I have the strongest reasons to think that these blisters are the result of the decomposition of the carbon, whose metallic base enters into union with the iron, and forms with it an *alloy*, while the other component element of the carbon is given forth, and so produces, in its escape, the blisters in question. On this assumption, we come to a very interesting question,—What is the nature of this gas? In order to examine this, all that is requisite is, to fill a wrought iron retort with a mixture of pure carbon and iron filings, subject it to a long-continued red heat, and receive the evolved gas over mercury. Having obtained the gas in question in this manner, then permit a piece of polished steel to come in contact with this gas, and, in all probability, we shall then have *reproduced*, on the surface of the steel, a coat of carbon, resulting from the re-union of its two elements; namely, that of the metallic base of the carbon then existing in the steel, with the, as yet, unknown gas; thus synthetically, as well as by the analytic process, eliminating the true nature of steel, and that of the elements or components of carbon.

MISCELLANEOUS.

16. *Sale of Indian Tea at Kumaon.*—From Kumaon we learn that the sale of tea, the produce of the province for the last year, came off at the Capital on the 10th instant, with a result extremely *favourable* to the ultimate success of the experiment. The attend-

ance, on this occasion, Native and European, was, we understand, very encouraging in number and respectability, and very many held commissions from stations near and remote, far exceeding in amount the quantity exposed for sale. We have not access to the records of the sale; but from the information of our correspondents, we are induced to believe that the price has advanced about a third on that of last year. Notwithstanding an extremely dry and unfavourable season in Kumaon, we hear that the produce of 1848, under the arrangements of Mr Jameson and his assistants, is likely to triple that of 1847.—*Mountain Monitor, published at Simla, in the N. W. of India.*

17. *The Himalayan Alpine Land.*—The vast limitary range of snows to the north of India, has been known in all ages by names derived entirely from Sanscrit, the Greeks and Romans neither coining fresh appellations nor even translating the sense of the Indian ones into their own languages, but adopting almost unaltered the Sanscrit names they found. These are Hemáchal, Hema-achal, *snowy mountain*; Hemádri, Hema-adri, the same; Hemálaya, Hema-alaya, *place of snow*; Hemódaya, Hema-údaya, *source of snow*; (as Suryódaya, *source of sun or East*). From the last term the Greek Oëmodus is deduced without alteration. The following tables, shewing the relative height of the great Andean and Himalayan peaks, and the connection of the latter with the physical geography of northern India may prove interesting, since no one but myself I believe is in a position to note the connection of the snowy peaks with the distribution of waters quoad the eastern half of this magnificent theatre of nature's vastest display.

Andean Peaks.	Feet.	Himalayan Peaks.	Feet.
Sorato, ...	25,400	Nanda Devi, ...	25,749
Illimani, ...	24,350	Dhavalagiri, ...	27,060
Desya cassada, ...	19,570	Gosain than, ...	24,700
Descabesado, ...	21,100	Kanchan Jhinga, ...	24,000
Chimbarazo, ...	21,441	Cholo, ...	26,000

HIMALAYAN PEAKS.

Names.	Relations.
No known peak, ...	Basin of the Indus, Alpine Paunjab.
Nanda Devi (above Rohilkhand), ...	{ Alpine Gangetic basin, East end.
	{ Alpine Karnalic basin, West end.
Dhavalagiri (above Gorakpoor), ...	{ Alpine Karnalic basin, East end.
	{ Alpine basin of Gandac, West end.
	{ Naraini.
Gosainthan vel Dayabhang (above the valley of Nepal), ...	{ Alpine basin of Gandac, East end.
	{ Trisul. Alpine basin of Cusi, West end, Sún Cusi.
Khanchan Jhinga (above Sikim), ...	{ Alpine Basin of Cusi, East end, Tamvar.
	{ Alpine basin of Tishta, West end, Bomchu.
Cholo (above Bhutan), ...	{ Alpine basin of Tista, East end, Paionomchu.
	{ Alpine basin of Monas, West end, Baréli.

The latter of the above tables shews with distinctness the connection that exists between the greatest elevations of the snowy range and the aquatic system of the Sub-himalayas, so that the great snow peaks are really entitled to be considered *divortiæ aquorum* on the Indian side of the snows, whatever may be the case on the Tibetan side: and, it is observable that at those points where the transnivean origin of our river necessitates a partial reference of our aquatic system to extra Indian limits, there no such towering snowy peak seems to demark the alpine Sub-hemalayan basin as in cases where our aqueous system is altogether our own and Cisnivean. Thus we have no peak to define the basin of the Indus on its western or eastern margin. At least, I know of none, though Pargyúl may in part be considered a water-shed, and so, at the other end of the chain, may Chumalari. Both peaks, however, are detached and stand on the plain of Tibet. Cholo is near to Chumalari and not detached. Of the innumerable rivers of these regions the only ones with ascertained transnivean sources are the Indus, Sutlege, Karnáli, Saupu, and Arún, whereof the four first take their rise at Gangri, the great water shed of the plain of Tibet, close to Lake Mepang vel Manasrovar, and the fifth or Arun from the northern slope of Hemáchal in the district of Tingri. These five rivers are, as might be expected, the largest of the whole, both the Karnali and Arun exceeding the Ganges or Jumna within the mountains, and being nearly equal the one to the other. Gangri is probably the Kailas of the Hindus, whence diverge to the four quarters of the compass the four great rivers of Bhárat des. I have said above that only five of our rivers have trans-hemalayan sources. It is however probable, though unascertained, thrt the Painomchú and Monas arise beyond the snows, and are identical respectively with the Naivel Pá-chu and the Mon-chú of Klaproth. Chú vel Tchú means river, so that in the one case we have an absolute identity of names, and nearly so in the other (Pá-Pai the root).

Klaproth's determination to make the Sanpu something else than the Brahmaputra, has led him to overlook the several large streams descending into Bhutan and Assam. Had he been aware that his Shokbaja is Sho vel Bhutan, and his Mon vel Moun the Cis-hemalays generally, he must have been more accessible to recent evidence against his theory.*

With regard to the heights of the Hemalayan peaks, of the five given, the two first are Webb's and Herbert's, the third Colebrook's, and the fourth and fifth Waugh's, communicated verbally, the results of his recent operations not having yet been completely worked out. The peak called by me Cholo, Captain W. supposes to be Chumalari; but the natives say otherwise. Captain W.'s positions for triangulation† were at 85 miles distance. Captain Herbert justly

* *Memoirs relatifs à l'Asie* 3, 370—417 and Map.

† Tanglo and Singchal in Sikim, 10 miles apart.

observes, that unequalled and vast as is the elevation of the Giants of Hemachal, no adequate conception of the vast mountain mass can be formed by merely adverting to them. The best way is to contemplate the whole extent and general elevation of the snowy region spreading over some 1800 to 2000 miles, with a breadth or depth of 20 miles, peaks above 5 miles high, distributed throughout *its whole extent*, and passes similarly extended, yet *seldom or never falling below 15,000 feet*; and all this though we admit Humboldt's somewhat theoretic negation of the general opinion, that Hemachal, and not, as he contends, Kuenlun, is the chain which divides Asia from end to end!—*B. H. Hodgson, Esq.*

18. *Tarnaway Forest in the Highlands of Scotland.*—Few knew what Tarnaway was in those days,—almost untrodden, except by the deer, the roe, the foxes, and the pine-martins. Its green dells filled with lilies of the valley, its banks covered with wild hyacinths, primroses, and pyrolas, and its deep thickets clothed with every species of woodland luxuriance, in blossoms, grass, moss, and timber of every kind, growing with the magnificence and solitude of an aboriginal wilderness,—a world of unknown beauty and silent loneliness, broken only by the sigh of the pines, the hum of the water, the hoarse bell of the buck, the long wild cry of the fox, the shriek of the heron, or the strange mysterious tap of the northern woodpecker. For ten years we knew every dell, and bank, and thicket, and, excepting the foresters and keepers, during the early part of that time, we can only remember to have met three or four individuals.—*Allen's Deer Stalking.*

19. *The Himalayan Mountains not favourable for Colonization.*—Such data, fortified by experience, will enable us to rate at its proper worth the colonisation cant which so often fills the gazettes, combined with the most exaggerated pictures of Himalayan resources, and the most chimerical schemes for railways, in a country where we are only too happy to find any roads at all. In sober truth, the resources of the mountains are not many, and are already as much developed as the nature of the country will admit of. Consequent on the cost of transport, the timber, tar, iron, hemp, madder, &c., cannot, at any remunerating price, come into competition with the water-borne articles of Europe, and other maritime lands; or the supply already equals the demand. The soil, except in the low valleys where the European colonist cannot exist, is generally poor, besides being pre-occupied, and often exhausted, by the aboriginal population. Of the feelings with which these would regard any extensive immigration of agricultural Europeans, we may judge by the dissatisfaction with which they relinquished the comparatively trifling lands required for the Tea plantations. The fine tracts of rich meadow, which flank the Snowy Range, are too remote for settlers, and are too high and too cold to ripen grain. It is certainly less salu-

brious than is commonly supposed, and seldom so cool as to admit of European out-door labour. Everywhere we encounter miserably diseased objects amongst the natives, much to be ascribed to filthy habits, no doubt; and up to 5500 or 6000 feet, the amount of sickness amongst Europeans, though not of a serious description, is considerable, and of a nature which singularly indisposes and unfits the subject for occupation. Such, too, is the power of the sun at *all* elevations, from April till October, between 9 A.M. and 4 P.M., that Europeans, can rarely, with impunity, brave its rays. The mean annual temperature, at 7500 feet elevation, is nearly that of London; but the fact that few of the trees indigenous at that altitude, can stand an English winter, points to a signal difference of conditions in the distribution of Himalayan heat and moisture. Dr Royle well observes, after the astronomers, that, in advancing north from the equator, the sun passes over 12° in the first month, 8° in the second, and only $3\frac{1}{2}^{\circ}$ in the third; and that, hence, from his longer presence there, and the greatly increased length of the day, the heat is more intense at the tropic than at the equator; at the former the sun is more or less vertical for about six days only; at the latter for nearly two months. The distance of the Himalaya from the northern tropic is not great; and where we have a southern exposure, is more than compensated; *there* indeed, the sun's rays strike vertically with intolerable power, augmenting in the ratio of our ascent, so that one is absolutely scorched while walking on a glacier. What a contrast also between the generally serene brilliant sky, and extremely dry atmosphere of the Himalaya, during eight or nine months of the year, and the cloudy canopy which so generally rests over the British Islands! The sun's arrival at the Tropic of Cancer is marked here by that of the rainy season, when the previously dry atmosphere is suddenly, and for three months, saturated with moisture, with a sun potent enough to knock down an ox, when he does shew himself, which is not seldom. During this period, one is alternately baked and chilled half a dozen times during the twenty-four hours, and that not in the low confined valleys, but upon perfectly open ridges, such as Almorah, where it is, consequently, a matter of some difficulty to adjust one's clothing to the frequent fluctuations of temperature, the annual change of dress which Mr Fortune describes amongst the Chinese being here diurnal. The result at Almorah, Kussowlee, &c., appears to be as much, though not so dangerous sickness, as in the much abused plains.

If the above be a true view of the case, it appears chimerical to hope that the Himalaya can ever maintain an independent body of colonists, such as might supersede the necessity of drawing recruits from Europe, or such as, on any emergency, could be brought down to act in the defence of the Lower Empire. This is a very different question from that of the fitness of the mountains for sanitary settlements occupied by those in the service of Government, and

whose means of subsistence are drawn from the Plains; that, indeed, is no longer a question a hundred applications for every vacant appointment in the mountains attest.—*Major Madden in Journal of the Asiatic Society of Bengal*, No. xviii. (New Series), p. 420.

List of Patents granted for Scotland from 22d September to 22d December 1848.

1. To ROBERT THOMSON PATTISON, of Glasgow, in Scotland, printer, "an improved preparation or material for fixing paint or pigment colours on cotton, linen, woollen, silk, and other woven fabrics."—26th September 1848.

2. To WILLIAM SOUTHAM, of Nuneaton, in the county of Warwick, miller, "improvements in cotton mills, or in machinery for pulverizing corn grain or seeds."—26th September 1848.

3. To WILLIAM LOSH, of Newcastle-upon-Tyne, "improvements in steam-engines."—26th September 1848.

4. To JAMES PETRIE, of Rochdale, in the county of Lancaster, engineer, "certain improvements in steam-engines."—26th September 1848.

5. To THOMAS SPENCER, of Prescott, in the county of Lancaster, earthenware manufacturer, "certain improvements in machinery, or apparatus for manufacturing pipes or tubes from clay, or other plastic materials, part or parts of which improvements are applicable to the manufacture of hollow earthenware."—27th September 1848.

6. To JOHN DAVIE MORRIES STIRLING, of Black Grange, N. B., Esq., "improvements in the manufacture of iron and metallic compounds."—2d October 1848.

7. To GEORGE ROYCE, of Fletland, in the county of Lincoln, miller, "improvements in machinery or apparatus for depositing, cleansing, and grinding corn and seed; also in apparatus for dressing the meal or flour made from wheat and other grains."—2d October 1848.

8. To WILLIAM SAGIR, of Rochdale, in the county of Lancaster, wool-dealer, "certain improved means and apparatus for effecting the transit or conveyance of goods, passengers, and correspondence, by land or water, and for other such purposes, part or parts of which means and apparatus constitute a new and improved method of generating steam,

which improvement is applicable to other purposes to which steam is generally applied as a motive power."—3d October 1848.

9. To RICHARD COAD, of Kennington, in the county of Surrey, chemist, "improvements in the combustion of fuel, and in applying the heat so obtained."—6th October 1848.

10. To ANDREW PATON HALLIDAY, of Manchester, in the county of Lancaster, manufacturing-chemist, "certain improvements in the manufacture of pyroligneous acids."—10th October 1848.

11. To WILLIAM WILKINSON NICHOLSON, of Alton Street, Gray's Inn Road, in the county of Middlesex, civil engineer, "improvements in machinery for compressing wood and other materials requiring such a process."—10th October 1848.

12. To ALONZO BUONAPARTE WOODCOCK, of Manchester, "improvements in steam-engines, and in apparatus for raising, forcing, and conveying water and other fluids."—13th October 1848.

13. To JOHN JAMES COLE, of Lucas Street, in the county of Middlesex, engineer, "certain improvements in steam-engines."—25th October 1848.

14. To HARRY JOSEPH PERLBACK, of Hamburg, founder, "an improved method or methods of uniting certain metals and alloys of metal."—25th October 1848.

15. To PETER FAIRBAIRN, of Leeds, in the county of York, machine-maker, "improvements in machinery for heckling, carding, drawing, roving, and spinning flax, hemp, tow, silk, or other fibrous substances."—30th October 1848.

16. To JOSEPH EUGENE ASAERT, of Lille, in the Republic of France, "improved means of obtaining motive power."—30th October 1848.

17. To ISAIAH DAVIES, of Birmingham, in the county of Warwick, engineer, "improvements in steam-engines and locomotive carriages, parts of which are also applicable to other motive machinery."—31st October 1848.

18. To THOMAS JOHN KNOWLEYS, of Heysham Tower, near Lancaster, Esquire, and WILLIAM FILLIS, of Shirley, in the county of Hants, mechanic, "improvements in generating, medicating, and applying heat."—6th November 1848.

19. To HENRY BESSEMER, of St Pancras Road, in the county of Middlesex, engineer, "improvements in the manufacture of glass."—6th November 1848.

20. To CHARLES GREEN, of Birmingham, in the county of Warwick, patent brass-tube manufacturer, and JAMES NEWMAN, of Birmingham, manufacturer, "improvements in the manufacture of a part or parts of railway wheels."—14th November 1848.

21. To THOMAS JOHN KNOWLEY, of Heysham Tower, near Lancaster, Esquire, "improvements in the application, removal, and compression of atmospheric air."—14th November 1848.

22. To THOMAS GILL and JOHN EDGECUMBE GILL, of Plymouth, manufacturers, "improvements in the manufacture of manures."—15th November 1848.

23. To ALFRED VINCENT NEWTON, of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, mechanical draughtsman, "certain improvements in the manufacture of steel;" being a communication from a Foreigner residing abroad.—20th November 1848.

24. To GEORGE REMINGTON, of Warkworth, in the county of Northumberland, civil engineer, "improvements in locomotive engines, and in marine and stationary engines."—20th November 1848.

25. To JOHN ARMSTRONG, of Edinburgh, in the county of Mid-Lothian, brassfounder, "improvements in constructing water-closets."—23d November 1848.

26. To EDWARD DUNCOMBE LINES, of Chelsea, soda-water manufacturer, and SAMUEL LUZ FREEMONT, of Love Lane, in the city of London, "improvements in the manufacture of colours, oils, and varnishes, acids, and spirits; and in the manufacture of charcoal; and also in treating vegetable substances for, and in obtaining and treating extractive matters therefrom."—24th November 1848.

27. To JOSEPH LEWIS, of Salford, in the county of Lancaster, machine-maker, and WILLIAM MACLARDY, of the same place, manager, "certain improvements in machinery, or apparatus applicable to the preparation and spinning of cotton, wool, silk, flax, and other fibrous substances."—27th November 1848.

28. To JOHN HARRIS, of No. 4 Richard's Terrace, Albion Street, Rotherhithe, in the county of Surrey, engineer, "a mode or modes of founding types, and of casting in metal, plaster, and certain other materials."—28th November 1848.

29. To ALEXANDER PARKES, of Birmingham, in the county of Warwick, chemist, "improvements in the manufacture of metals, and in coating metals."—30th November 1848.

30. To ALEXANDER BALFOUR, of Dundee, in the county of Forfar, Scotland, leather-merchant and manufacturer, "improvements in apparatus

for cutting metal washers and other articles, and in the construction of buffers."—4th November 1848.

31. To CHRISTIAN SCHIELE, of Manchester, in the county of Lancaster, mechanician, "certain improvements in the construction of cocks or valves, which improvements are also applicable for reducing the friction of axles, journals, bearings, or other rubbing surfaces of machinery in general."—4th December 1848.

32. To WILLIAM YOUNG, of the firm of Henry Bannerman and Sons, of Manchester, in the county of Lancaster, merchant, "certain improvements in machinery or apparatus for winding, balling, or spooling thread-yarn, or other fibrous materials."—8th December 1848.

33. To ALFRED VINCENT NEWTON, of the Office for Patents, No. 66 Chancery Lane, in the county of Middlesex, mechanical draughtsman, "improvements in casting printing types and other similar raised surfaces, and also in casting quadrats and spaces;" being a communication from a Foreigner residing abroad.—11th December 1848.

34. To JAMES HENRY STAPLE WILDSMITH, of the City Road, experimental chemist, "improvements in the purification of naphtha (likewise called wood-spirit and hydrated oxide of naphtha), pyroligneous acid and cupion, and certain other products of the destructive distillation of wood, peat, and certain other vegetable matters, and of acetate of lime and shale, and in the purification of coal-tar and mineral naphtha, likewise spirits, being the product of fermentation."—12th December 1848.

35. To HENRY NEWTON, of Smethwick, near Birmingham, in the county of Stafford, "an improvement or improvements in trusses."—13th December 1848.

36. To DUNCAN MACKENZIE, of Goodman's Fields, in the county of Middlesex, manufacturer, "certain improvements in Jacquard machinery for figuring fabrics and tissues generally, and apparatus for transmission of designs to the said Jacquard machinery, parts of which are applicable to playing musical instruments, composing printing types, and other like purposes."—22d December 1848.

(New Publications will be noticed in our next Number.)

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

Obituary Notice of Lieutenant George Augustus Frederick Ruxton. By Dr KING. Communicated by the Author.*

MR RUXTON was born on the 24th of July 1821. He was the third son of John Ruxton, Esq., of Broad Oak, Brenchley, Kent, and of Anna Maria, daughter of the late Colonel Patrick Hay, a lineal descendant of the noble house of Tweeddale.

Many individuals, even in the most enterprising periods of our history, have been made the subjects of elaborate biography, with far less title to the honour than Mr Ruxton. Time was not granted him to embody, in a permanent shape, more than a tithe of his personal experiences and strange adventures in three quarters of the globe; indeed, when we consider the amount of physical labour which he endured, and the extent of the fields over which his wanderings were spread, we are almost led to wonder how he could have found leisure even to have written so much. Mr Ruxton commenced his education at Tunbridge School, whence he went to Sandhurst; but his chivalrous spirit was such, that he left the college without waiting for his commission, to learn the practical part of the duties of a soldier on the field of civil war raging in the peninsula of Spain in 1837 and 1838. He joined the cavalry under Don Diego Leon, and was present in the following actions: 1839, capture of Los Arcos; March 7, action of Villatuerta and affair of the Ega; April 17 and 18, action of and taking the fortified bridge and entrenched height of Belascoin; April

* Read before the Ethnological Society, 20th December 1848.

29 and 30, and May 1 and 2, action of Arroniz; May 10 and July 3, action of the Val de Berrueza. For these services, but more especially for his gallantry at Belascoin, he was created, by Isabella II., a "Knight of the first class of of the Order of St Fernando," receiving the royal permission to accept and wear the order in the British service; and, on his return from Spain, at the close of 1839, he found himself gazetted to a commission in the 89th regiment, which corps he immediately joined in Ireland.

It was while serving with this regiment in Canada that he first became acquainted with the stirring scenes of Indian life which he has since so graphically portrayed. The "open Prairie" and "the Indians," was just the field of adventure which suited his organization, both mental and physical, and, yielding to that impulse which in him was irresistibly developed, he resigned his commission, and directed his steps to the Indian wigwam, and to the wild, enchanting scenery around it,—a land only tenanted by the Red man or the solitary American trapper. Those who are familiar with his writings cannot fail to have marked the singular delight with which the author dwells upon the recollections of this portion of his career, and the longing which he carried with him to the hour of death for a return to those scenes of primitive freedom. "Although liable to an accusation of barbarism," he writes, "I must confess that the very happiest moments of my life have been spent in the wilderness of the far west; and I never recall but with pleasure the remembrance of my solitary camp, with no friend near me more faithful than my rifle, and no companion more sociable than my good horse and mules, or the attendant cayute which nightly serenaded us. With a plentiful supply of dry pine logs on the fire, and its cheerful blaze streaming far up into the sky, illuminating the valley far and near, and exhibiting the animals, well fed and at rest over their picket-fires, I would sit cross-legged, enjoying the genial warmth, and, pipe in mouth, watch the blue smoke as it curled upwards, building castles in its vapoury wreaths, and in the fantastic shapes it assumed, peopling the solitude with figures of those far away. Scarcely, however, did I ever wish to change such hours of freedom for

all the luxuries of civilized life ; and, unnatural and extraordinary as it may appear, yet such is the fascination of the life of the mountain hunter, that I believe not one instance could be adduced of even the most polished and civilized of men, who had once tasted the sweets of its attendant liberty and freedom from every worldly care, not regretting the moment when he exchanged it for the monotonous life of the settlements, nor sighing and sighing again once more to partake of its pleasures and allurements."

The vast store of interesting information which Mr Ruxton gathered in the far west created a thirst for adventure of the most daring kind. It was to Africa that he first turned his attention, in order to add to our geographical knowledge some of its unexplored and hitherto inaccessible lands. His conversations to those to whom he communicated his plans were of the most stirring and convincing nature. The president of the Royal Geographical Society has given us, in his anniversary address to that body in 1845, his recollection of Mr Ruxton's conversation with him in these words :—

" To my great surprise I recently conversed with an ardent and accomplished youth, Lieutenant Ruxton, late of the 89th regiment, who has formed the daring project of traversing Africa in the parallel of the southern tropic, and has actually started for this purpose. Preparing himself by previous excursions on foot in North Africa and Algeria, he sailed from Liverpool early in December last, in the 'Royalist,' for Ichaboe, now so well known for its guano. From this spot he was to repair to Walwich Bay, at the mouth of the Kuiss river, where we have already mercantile establishments. The intrepid traveller had received from the agents of these establishments such favourable accounts of the natives towards the interior, as also of the nature of the climate, that he has the most sanguine hopes of being able to penetrate to the central region, if not of traversing it to the Portuguese colonies of Mozambique. If this be accomplished (and there are traditions of its having been done in former times by the Portuguese), then, indeed, will Lieutenant Ruxton have acquired a permanent name for himself among British travel-

lers, by making us acquainted with the nature of the axis of the great continent, of which we possess the southern extremity.

It was on the 18th of March 1845 that Mr Ruxton landed on the west coast of Africa, to push his adventurous way, accompanied by a single companion, a volunteer from the Royalist. Expecting to find vessels at Angra Pequena, the travellers took very little water and provisions. Their route along the coast was most fatiguing, from the moving sands, in which they sank at every step. The only vegetation was a stunted sand-plant, affording subsistence to a species of hare rather plentiful, and dwarfy scrubby myrrh plants, from which the gum freely exuded, though the shrubs were leafless, and apparently dead. The coast was found to be strewn with the wrecks of many vessels and boats. At sunset on the 20th they came in sight of Angra Pequena, where they saw only one vessel, and that in the act of getting under weigh, and too far off to see them. They sat down exhausted with fatigue, to reflect upon their hard fate. A single biscuit each, besides limpits found on the rocks, had been their only food for three days. They were unable to discover either the Fish River, or the three or four smaller streams denoted as falling into the sea between the Gariep and Walwich Bay,—geographical errors, which promised speedily to seal their fate. With an energy which has since been found so characteristic of the man, Mr Ruxton at once exclaimed, “For Ichaboe; it is there alone that we can hope for life.” And notwithstanding this wise step was immediately taken, they were still far from Walwich Bay on their homeward route, when, exhausted with heat, fatigue, and want of food, they had no alternative but to resign themselves to death. A party of Indians, however, discovered them in this dreadful condition, and by administering to their wants, enabled them to reach the Royalist, still at her anchorage.

Mr Ruxton had the misfortune to find that, from the jealousy of the traders established on the coast, and of the missionaries, he could get no assistance from the natives to enable him to prosecute his explorations into the interior; and *he was accordingly compelled to return to England.*

Short as untoward circumstances rendered this traveller's operations, he still had time to improve our maps, by expunging from them the Fish River, and other smaller streams. A detailed account of this all but fatal journey is inserted at length in the *Nautical Magazine* for January 1846.

Before leaving Africa, Mr Ruxton made himself acquainted with the manners and customs of the natural inhabitants of the almost inaccessible valleys of Snewbury, Meuweldt, and the desolate tracts of *Karoo*, or desert, extending from the northern boundary of Cape Colony northward nearly to the tropic. He contributed to the Ethnological Society of London, at its meeting of the 26th of November 1845, an able paper on the interesting people who are known by the name of Bushmen,—a race of human beings existing on locusts and the larvæ of insects, food sought by them as a luxury, and deemed the greatest blessing, which, to the rest of mankind, is a plague and a pestilence. Desolate and forlorn as is the condition of these poor creatures, Mr Ruxton describes his intercourse with them to be favourable to their morals, and adds, "Well may they be now called outcasts, when it is a matter of history that, in 1652, when the Dutch took possession of the Cape, they had large herds of cattle, which the *Whites* first obtained by barter, and ultimately by force, a system of persecution which drove them from desert to desert, 'their hand raised against every man, and every man's against them.'"

Nothing daunted by the peril of his first adventure in Africa, and still having the same conception, to use the words of the President of the Royal Geographical Society, of his "daring project of traversing Africa in the parallel of the southern tropic," he asked, again and again, from Her Majesty's Government some little assistance to enrich his private resources, which ended in the application being referred to the Geographical Society for its opinion, and that opinion being filed in the archives of the Colonial Office,—an opinion, be it said, equally to the credit of the Society and of Mr Ruxton,—expressed, without loss of time, strongly in its favour. Delay followed delay, which our adventurous traveller

could no more brook than those who have trodden before him the same crooked path, destined, like himself, to perform great works with little means, but that the Government was incapable of appreciating the rich store-houses it resolved to lay waste, and he consequently withdrew from the field of research in Africa.

To Mexico Mr Ruxton now bent his course, where he was not only a silent observer of the sanguinary assault and capture of Monterey by General Taylor, but of the proceedings of the corps called Texan Rangers, a body of men formed out of the wildest and most dissolute class in the State of Texas. Civilised society has scarcely offered a parallel to the excesses committed by the Texan Rangers, except perhaps in those freebooting incursions notorious as the Santa Fe expeditions. Mr Ruxton left this scene of horror for Saltillo, now the headquarters of the American army, and upon which Antonio Lopez de Santa Anna was advancing with a large force. The trial of strength between the two armies, being, in round numbers, 4000 Americans against 18,000 Mexicans, was called the Battle of Buena Vista. Of this conflict Mr Ruxton thus expresses himself, "As at Monterey, at Palo Alto, and Resaca de la Palma, Taylor proved himself to be a *brave soldier* but no general; and although it is certain that the gallant little American army did all men could do in the way of fighting, yet their victory must be attributed more to the downright cowardice and incapacity of Santa Anna and his officers, than to the superior skill of their own general, or even their own undeniable and obstinate courage and endurance. Of the Mexican troops, it is almost unnecessary to speak. The Mexican soldier does not possess, in any degree, a single spark of what we understand by the word *courage*; but, like all uncivilised men, has that indifference to the fear of death, which would enable him to face perils of any kind, if led by an officer in whom he places the slightest confidence. The extraordinary successes of the Americans, during the present war, have resulted entirely from their superiority in courage, and in this alone; for there has scarcely been one action fought from the Palo Alto to the capture of the city of Mexico, in which the American generals have not

exhibited the most thorough ignorance of skilful tactics, and the most perfect contempt of military manœuvre; and depending entirely upon the known bravery of the troops under their command, all their successes have been gained at an immense sacrifice of human life." In *Frazer's Magazine* for July 1848, under the title of "Sketches of the Mexican War," will be found Mr Ruxton's narrative of the recent struggle between the Americans and the Mexicans.

The social condition first of the Mexicans and the Mexican Indians, and afterwards of the North American Indians, now engrossed Mr Ruxton's whole attention; and it is merely necessary to mention, that the title under which this accomplished traveller wrote is "*Adventures in Mexico and the Rocky Mountains*," in order to call forth anew that admiration for the author which has seldom been bestowed so universally upon one of the contributors to the series of the *Home and Colonial Library*, of which these adventures form a part. It divides, with *Madame Calderon de la Barca's* well-known volumes, the merit of being the best narration extant of travel and general observation in modern Mexico. "No traveller," writes a talented reviewer, "has presented himself to the world, we dare avouch, with a tale better worth hearing than this. We are struck by the answer which such adventures as this give to those who are forever complaining of the enervating influences of civilisation; as if comfort, intelligence, and self-command, were to drive manhood out of the world. What do they who believe that no strength would be forthcoming in this silken age, were it wanted, make of a *Lady Sale*? What of a *Rajah Brooke*? What of such an autumn tourist as Mr Ruxton. The fine old times of 'bow and spear,' the days when geographical discovery took such strange forms and colours from superstition, did not yield a better heroine and better heroes than these have proved themselves."

To the *Ethnological Society of London* Mr Ruxton made a contribution, as one of the results of his Mexican adventures, in the form of a paper "*On the Migration of the Ancient Mexicans, and their Analogy to the existing Indian Tribes of Northern Mexico*." The *Ottomies*, in Mr Ruxton's opinion,

are the aborigines of that portion of Mexico classically known as the Valley of Anahuac, a certain analogy being traceable in their character and habits to the savage tribes of Apaches who infest the northern states of Mexico at the present time ; and these Apaches are the aborigines of New Mexico. From the Apaches branch the Pueblos, Navajos, Apaches Coyoteros, Mescaleros, Moquis, Yubissias, Maricopas, Chiricaquis, Chemeguabas, Yumayas, which are tribes of the Moquis, and the Nijoras, a small tribe on the Gilá, all of whom speak the Apache, with some slight dialectical difference, the idiomatic structure being the same. These people, Mr Ruxton remarks, are eminently distinguished from the New Mexicans or descendants of the Spanish conquerors, in their social and moral character ; being industrious, sober, and honest ; the women as remarkable for chastity, as the New Mexicans are notorious for the laxity of their morals. "That the ancient Mexicans had attained to any other than the most primitive stage of civilisation is not borne out by *any remains* which are left in these days to direct our judgment, and that, if the historians who have worked up into romance the meagre materials afforded by Mexican history had written only what they conscientiously believed,—if the ancient Mexicans had been described to be, what in truth they were, and no more, a tribe of Indians dwelling in lodges of stone, and living by agriculture,—we should be better able to appreciate their real state, and to draw a just comparison between the pomp and glory of the court of Montezuma, and the regal splendour displayed at the present day in the Medicine Lodge of Tum-ga-cosh or Buffalo Belly, the chief of the mighty nation of the Comanche." "Life in the Far West" is another of Mr Ruxton's vigorous productions, which has so completely gained the suffrages of the public as not to need commendation at my hands. It first appeared in Blackwood's Magazine ; but is now published in a separate form.

From a traveller of Mr Ruxton's pretensions, whose touches fall on the paper with that bold and clear mark which bespeaks strength, and animal spirits, and powers of observation, in a healthy state, "the Oregon Question" was not likely to escape his notice. In a pamphlet published by Mr

Ollivier of Pall Mall, Mr Ruxton took "a glance at the respective claims of Great Britain and the United States to the Territory in Dispute," which he has worked out historically and logically, with his usual master mind.

When we reflect that all we have stated is the work of one who had but just attained his twenty-seventh year, and that he has been suddenly taken from us, a victim to climate, in the active prosecution of farther research,—a working-bee collecting food for his kind,—we cannot help deeply lamenting his loss, and paying a lasting tribute to his memory by placing on record in the *Journal of the Ethnological Society*, this imperfect sketch of his short but useful life.

On Ancient Sea-Margins, with Observations on the Study of Terraces. By JAMES D. DANA. 21

Mr R. Chambers, in his work on "Ancient Sea Margins,"* has entered upon a subject of great scientific interest. It rises beyond the study of isolated deposits, or local phenomena, and embraces facts bearing upon the geological history of whole continents, indicating wide changes in the earth's surface, and the latest of this general nature our globe has undergone. The truth, moreover, is exhibited in characters which cannot be mistaken, even by the mind unaccustomed to geological evidence. It is marked in the condition of the soil, and in the extent and features of the fields of our valleys; and even the higher country along the smaller streams, bears evidence that the same causes have there modified the main outlines of the land, and determined its variations of character. The farmer is well aware of the distinction of upper and lower plain or prairie along our streams; and knows that he often may distinguish the different flats by the peculiarities of soil they present.

It is a long time since the terraces of valleys and sea-shores

* *Ancient Sea Margins, as Memorials of Changes in the relative level of Sea and Land.* By Robert Chambers, Esq., F.R.S.E., 338 pp. 8vo.

were first noticed; yet hitherto only isolated cases, or particular valleys have received much attention. Mr Chambers is the first who has collected together the various observations, and from these and other results of his own, has endeavoured to arrive at a general deduction for the whole. He concludes that those of different countries point, in many instances, to a single cause, operating simultaneously over distant regions. He observes:—

“There is nevertheless enough to justify a question regarding uniformity of level, not only throughout North America, but also—bold as the idea, in the present state of knowledge and of hypothesis, may appear—between the old and the new continents. It has certainly appeared to myself, to say the least, as a promising prognostic of some important new views regarding a chapter in the past history of the globe, when, it being granted that terraces and benches of land are marks of ancient levels of the sea, I find that a tendency to a bench form or plateau, at 60, or from 60 to 70 feet above present high water, exists on the coasts of the United States and in the Gulf of St Lawrence, as it does in Britain; that conspicuous terraces in Britain and in France at 188 and 392 feet are repeated in America; that there, also, at about 545 feet, are several repetitions of a decided and most notable Scottish terrace—that Scott built his house of Abbotsford on an ancient sea-beach beside the Tweed, which finds an analogue in the first of the grand ridges sweeping from east to west behind Toronto; and that the sandy plateaux of Lanark and Carstairs are in metrical harmony with the terraces and ridges of the half-peopled wilds of Michigan.”—P. 316.

This must be viewed as a bold inference, and should not be admitted without extended investigation. It is certainly a legitimate subject of enquiry, and one of the grandest in its range, before the geologist. If proved, it declares that the causes of variation in the water-line, in the recent history of the globe, have acted at certain periods as widely as the ocean. If disproved, the facts indicate changes no less extensive, which have been produced at different epochs for different regions, and they shew a still greater instability in the earth's surface, telling of oscillations in its various parts continued through ages since the tertiary epoch, until a whole continent has been terraced in all its valleys.*

* In connection with the subject of Terraces, we add a remark here on the

Mr Chambers introduces the subject with the following statements :—

“ The most familiar phenomenon connected with this subject is the existence of stripes, as well as broad expanses of low land bordering on the sea, in many districts of a very equable surface, sometimes of sandy, sometimes of clayey composition, occasionally presenting beds of shells; comprehending, in short, the great bulk of those flat tracts which have been—usually on account of the latter feature—recognised as ancient beaches, comprehending also the well-known *carses* of Scotland, as well those still lower sandy tracts near the sea, called in our country *links*, and in England *downs*. The class of lands so described may be said to form an irregular fragmentary belting round the island, strikingly distinct from the higher grounds which rise inland, generally of great agricultural value, and remarkable as forming the sites of many of the principal towns of the empire, or of large portions of them. As they almost everywhere tell a plain tale as to their former submergence by the sea, the idea may the more naturally occur that, were they by any accident re-immersed, a very important deduction would be made from the geographical area, and still more from the productive resources of our island.

“ As striking examples of this class of lands, I may point to the sea-side plain, stretching for several miles on both sides of Chichester; to the similar plain extending along the south shore of the Bristol Channel,

word *drift*, as it is often used. It is frequently applied to any loose material on the surface, not originating where found, whether *stratified* or *unstratified*. This name being affixed to any accumulations, one or another *drift theory* comes in to account for the facts—such as the currents and icebergs of an ocean over the submerged lands, the action of waves of translation, or the movement of glaciers. The term in its very nature implies a theory of this general character. But there is much material of the kind called drift, which may be of sea-shore or beach accumulation; there is much also which may be of river origin, and much that may be lacustrine. Instead of determining by observation the actual facts in the different cases, and carefully discriminating, the mind is led away by the term *drift* at once to prejudge, to the confusion and error of observations. In its general signification, it had better therefore be rejected; such truthful terms as *earth, sand, gravel, clay, boulder accumulations*, are preferable, until it is fully determined that the material in any case is true drift, and not alluvial, lacustrine, or of beach or sea-shore origin. First prove it to be drift (often a difficult problem), and then so designate it, is a safe rule.

We have been led into these remark, by observing, not unfrequently, that river terraces and beach deposits were ranked with the drift; and when once so called, every succeeding step in investigation leads into deeper error.

between Weston-super-Mare and Bridgewater, and to the broad expanse of low land in Lincolnshire and other parts of eastern England. The carses along the Forth and Tay, vast alluvial plains, the low gravelly lands of Moray, and the alluvial grounds skirting the Clyde near Glasgow, are examples of equally signal character in the northern part of the island.

"It may, I believe, be safely said, that a sea 44 feet above the present would cover the whole of the districts referred to, excepting, perhaps, a few patches. The base of the comparatively steep ground rising from the interior line of these plains and stripes, even when they reach the highest grade of height, is usually at about that elevation above the sea, or a little lower. An immersion, therefore, to this extent, would leave us with new coasts, not only much circumscribed, but considerably different from the present—for one thing, much bolder. It would also deprive us of the sites of the lower parts of London, Bristol, Liverpool, Newcastle, Glasgow, Aberdeen, and Inverness, and of the entire sites of Portsmouth, Southampton, and Chichester, of Hull, Dumfries, Greenock, Leith, and Perth. The same submersion, extended to the Continent, would blot no small space from the map of Europe.

"Where we have large expanses of these low lands, the flatness is usually very striking. For instance, in an extensive plain beside the Bristol Channel, the equability is so great over large areas, that the Exeter Railway passes over it for twenty-eight miles (from Ashton Water to Claverham Court), with a gradual rise of only four feet; and even this, perhaps, is to be attributed to the lines taking an oblique course athwart the plain, and against its sea-ward declination. Such equability makes the land almost the rival of the sea in the trueness of its surface to the centre of the earth, and forcibly suggests that water was concerned in giving it such a configuration. Such a plain is, indeed, precisely what would be presented to us as a piece of new land, if some of our shallow seas, such as the Bristol Channel, the mouth of the Humber, or the Solway Frith, were to sink forty feet below their present level. The carses in Scotland are also generally level, though not without partial inequalities, which a slight examination suffices to detect. In the configuration of the ground, thus level with, in many places, the small inclination proper to a beach over which the tide rises and falls; in the cliffs which are often seen rising along the interior limit of the plain; in the constitution of the soil, composed of layers of sand or of clay, or of both, alternating often with beds of shells, we see clear evidence that these grounds were formed along the margins of an ancient sea, the highest inland part speaking of one about 44 feet above the present. Such is the announcement from these great expanses. When we look, however,

to narrower examples of the great belting, such as are presented on bolder coasts, we find precise demonstrations, not only of an ancient sea-level about 44 feet above the present, but of several others intermediate between that and the present, particularly at 32, 27, 20, 11, and 8 feet, such appearing in the well-defined form of terraces or benches of land, the unavoidable result of the wearing power of the sea when it abuts against land of suitable slope and consistence; and, as already almost implied, these memorials of ancient sea-levels conform with each other in various parts of the island."—Pp. 6-9.

Mr R. Chambers' volume is occupied with details of facts from Scotland and other parts of Great Britain, and afterwards from the continent of Europe, and foreign countries generally.

A brief abstract is here presented in a tabular form, first of terraces occurring in the vicinity of the sea, and next of those existing in the interior. We have preferred this arrangement, which differs from Chambers' own table, for reasons mentioned beyond.

1. *Terraces in the Vicinity of the Sea. (Height in Feet above High Tide.)*

Frith of Tay—									
Near Dundee	20-26	...	56	...	...	...	...	...	208-13, 389
Newburgh	...	...	56	...	...	...	...	...	...
Bambreich	...	...	56	...	...	...	...	...	...
Balmerino	...	...	...	60-70	...	...	...	...	...
Errol	20	...	56	...	...	...	...	...	...
Between Frith of									
Tay and Frith									
of Forth—									
Leuchars	20	...	56	70	107	...	...	...	...
St Andrews	...	...	56	64-70	117	126	...	192	...
Fife to Crail	...	...	...	...	...	...	165	...	...
Pipeland Farm- stead	...	...	...	...	...	126	...	203	325, 465, 545
Moray or Murray									
Frith—									
Fochabers	...	...	...	...	...	126	141-165	...	280
Inverness	...	...	...	...	96-117	...	...	...	...
Frith of Forth—									
Leven and Dun- barnie	10	...	...	...	...	...	...	...	...
Portobello	21-25	...	...	...	...	...	...	...	...
Musselburgh	20	...	...	...	110	...	...	...	...
Kirkcaldy	25	...	56	64-80	100	125	...	186-190	...
Stoneyhill Villa ..	...	...	56	...	...	...	...	...	...
Between East Duddingston and the sea ...	...	...	...	70-85 or 90	...	...	...	...	...
Edinburgh	20	...	56	70	110	...	165	186-200	280
The Tweed—									
Berwick	30-32	44	56	...	...	...	...	...	...

Table—continued.

Frith of Clyde—									
Isle of Bute.....	27-32	...	...	64	108	...	...	...	...
Dumbarton.....	32	...	...	64	104	...	...	...	...
Glasgow.....	11-26	...	...	64, 70, or 80	...	...	...	...	...
Loch Linnhe, Loch Leven—									
At Ballachulish ...	...	42-44	...	65	...	...	...	...	...
Loch Etive—									
Connel Ferry	...	43	...	64-70	...	...	...	...	...
Fort William	32	...	...	70	96	...	165	187	...
Devonshire—									
Barnstaple Bay	...	...	...	60	...	...	...	...	...
near Exeter	...	...	...	67	...	126	...	...	...
Brixham, near	...	...	...	...	...	...	...	170-180	...
Torbay.....	...	...	...	...	...	...	...	...	...
Hope's Nose	...	...	...	64	...	...	...	...	...
Lancashire—									
Ribble.....	...	...	...	60-70	100	120-128	...	...	300
Liverpool.....	...	...	...	60-70	100	120-128	...	...	300
Seacombe and	...	...	...	60, 70, 85	...	...	...	...	...
Egremont	...	...	...	...	...	...	...	...	...
River Dee, at	...	...	...	60-72	...	...	...	...	...
Chester	...	...	...	...	...	...	...	...	...
River Severn, at	...	...	50-56	...	...	128	...	187-193	277-283
Bristol	...	...	...	...	...	...	...	...	...
River Thames, near	...	...	...	64-90	...	...	145-150	...	...
London	30	...	...	...	...	...	...	...	...
Sussex, near Brighton	...	...	...	64	...	...	...	...	...
Chichester	...	...	43	...	...	112-128	...	...	...
Chicham	...	...	...	...	...	128	...	...	...
Hampshire, South-	...	...	...	...	...	...	...	...	...
ampton Water }	...	...	...	66	...	...	...	...	...
Isle of Wight	...	...	...	64	...	128	...	...	...
Rouen	...	43	55	69	...	126	...	...	...
Norway, near North	...	...	50	78	...	...	...	...	...
Cape.....	...	...	...	...	...	...	...	...	...
Spitzbergen	...	...	...	...	...	128	...	...	...

From the above table there are evidently terraces of nearly the same height above the sea, common to distant regions. These heights are approximately 20 feet, 30-32, 44, 56, 64-70, 107-117, 126, 165, 185-190, 280 feet, and probably others.

2. Terraces in the interior, remote from the sea. (Height above high tide.)

VALLEY OF THE TAY.—Junction with the Isla (93 feet above the sea), 146, 186.

Dunkeld (145 feet above the sea), 165, 280, 292.

Logierait, 281.

Beyond Killiecrankie, 497.

Blair-Atholl, 500.

Taymouth (Loch Tay, 350 feet above the sea), 385.

FIFE, on the Eden.—West Lomond Hill, 466, 543, 758-60, 996, 1338?
Ceres and Teasses, 203, 280-293, 325-330, 465, 545, 573, 599.
Falkland, 203, 243.

STRATHSPEY.—Kingussie (about 710-720 feet), 760, 776, 792, 829, 853, 868.

Drumgellavy, opposite Kingussie, 997.

Farther up the valley, around a lake, 1104, 1131, 1261.

Loch Ness (45 feet), 104, 377, 497, 530.

Dunnain, 121, 165, 189, 220, 279.

Dochnacraig, 205, 344, 461, 562, 626.

Erchet, above Loch Ness, 497.

LOCHABER.—Loch Lochy (82-89 feet), 213.

Glen Spean and Glen Roy, 141, 167, 210, 325, 345, 372, 391,
428, 446, 520, 534, 627, 679, 703, 734, 750, 847, 1059, 1089,
1125, 1139, 1261, 1290, 1337.

GLEN GLUOY, 959-969, 1159-1169.

LOCH TULLA, Argyleshire (630 feet), 814, 907, 948, 1025, 1104, 1132.

BORTHWICK and EDINBURGSHIRE, 628, 656, 687, 706, 760, 821-6, 872,
968½.

BASIN OF FORTH.—Stirling, 106-117, 165, 211.

Markinch, Leslie, and Kinross, 285, 385-389, 448, 497.

VALE OF TWEED.—Kelso (83 feet), 108, 122, 168-178.

Melrose (270 feet), 346, 391-393, 445, 497.

Galashiels, 542.

Eildon Hills, above Peebles, 542, 628, 675, 708, 787, 829, 872-5,
914, 967, 1024, 1087, 1133, 1166, 1196, 1226, 1282, 1336.

LAUDERDALE, 800, 900.

Yarrow, 630, 656, 685, 709, 779, 824, 879, 958, 1081, 1126,
1186.

DUMFRIESSHIRE, Cannobie, 144, 165, 192, 219, 277, 320, 392.

Evan Vale, 1023, 1073.

BASIN OF CLYDE.—Lanark, 675, 687.

Lamington, 820, 872, 999, 1025, 1139.

Crawford, 826, 844, 910, 937, 962, 1025, 1090, 1107, 1171,
1204, 1251, 1286.

Newton, 912, 963, 1025.

VALE OF ALLAN, Northumberland and Weardale, Durham, 760, 826,
1073.

VALLEY OF THE SEINE (Upper part), 117, 126, 186-192, 238, 281, 307,
347-350, 393, 440-443, 461-465, 531, 545, 564, 576, 599,
629½.

Mr Chambers' work contains extended descriptions of the localities mentioned, illustrated by excellent drawings.

Among the most remarkable of the terraced valleys of Scotland are those of Glen Roy and the adjoining valleys, whose terraces are called the Parallel Roads or shelves of Lochaber. This region attracted the attention of MacCulloch in 1817, who published an elaborate article upon them in the *Geological Transactions*.^{*} Since then they have been the subject of study by Sir Thomas Dick Lauder,[†] Mr C. Darwin,[‡] Buckland, Agassiz,[§] Mr Kemp,^{||} Mr David Milne,[¶] Sir George S. Mackenzie,^{**} and Mr James Thomson jun.^{††} Speaking of these Lochaber terraces, MacCulloch says:—

The appearance of the Parallel Roads is so extraordinary as to impress the imagination of the most unphilosophical, nay, even of the most incurious spectator. * * * On each side of a long, hollow, deep valley, bounded by dark and lofty mountains, and at a great elevation, three strong lines are traced parallel to each other, and to the horizon, the levels of the opposite ones coinciding precisely with each other. So rarely does Nature present us in her large features with artificial forms, or with the semblance of mathematical exactness, that no conviction of the contrary can divest the spectator of the feeling that he is contemplating a work of art, a work of which the gigantic dimensions and bold features appear to surpass the efforts of mortal power.

Several views of the region are given by MacCulloch, and Chambers observed three lines extend for five or six miles

* *Trans. Geol. Soc. London*, vol. iv., 1817, p. 314.

† *Trans. Royal Society of Edinburgh*, 1818, vol. ix., p. 1.

‡ *Trans. Royal Society, London*, 1839, p. 39.

§ *Jameson's Edin. New Phil. Jour.*, 1842.

|| A writer in the *Athenæum*, of September 23, claims, for Mr Kemp of Galashiels, his having first investigated the inland terraces of Scotland, and states that his views, which are the same as are presented by Mr Chambers, were noticed in Chambers' *Journal* as early as 1840.

¶ *Jameson's Edin. New Phil. Jour.*, vol. xliii., p. 339, 1847.

** *Ibid.*, vol. xlv., p. 1, with a map, Jan. 1848. A previous memoir by Mackenzie was read on the subject before the Royal Society of Edinburgh in 1842, and a still earlier publication appeared in Brewster's *Phil. Journal* for 1833.

†† *Ibid.*, vol. xlv., p. 49, 1848.

on both sides of Glen Roy, and look like "copy lines ruled for text." The *first* and *second*, or two upper, were found by MacCulloch to be 82 feet apart, and the *second* and *third* 212 feet. A careful survey by Mr David Stevenson, according to Mr Chambers, made the latter 212·37 feet, and the former 80·32 feet, a close approximation to MacCulloch's determination. The height of the uppermost, above high tide, is 1139 feet; of the second, 1059 feet; of the third, 847 feet.*

Adjoining Glen Roy lies Glen Gluoy, which opens below upon Loch Lochy. This valley has two distinct shelves or terraces, one 1159 feet above high tide, and the other 959 to 969 feet. Other shelves occur in Glen Spean, as well as in Glen Roy, whose heights are mentioned in the table on page 210. The whole system has afforded a fruitful and most interesting subject of speculation. The "perfect horizontality" of the terraces (their height above the present bottom of the valley therefore diminishing upwards, instead of rising with the valley), their extent, and the character of the region around, are the bases of the two views recently urged, the one attributing them to inland lakes, the other regarding them as beaches of an arm of the sea.

Mr Chambers adopts the latter view; and as he discusses the character of the other terraces of Scotland and England, he arrives at the same conclusion for them all. He finds the same "ancient sea margins" in foreign regions. In France and North America he seems to detect terraces of equivalent height with those of Scotland, and all are set down as marking *former levels of the sea*. A natural terrace and a sea-beach are therefore, in his view, nearly synonymous terms.

We do not pretend to deny, without examination, the conclusion, in particular cases, carefully studied by Mr Chambers. But the sweeping deduction needs much, very much restriction. And even many of his own examples demand better proof of the former presence of the sea than has been presented.

The principle that "what has been, may again be, and the reverse," is acknowledged to be a safe test of truth in geology.

* MacCulloch observes, that the first is 927 feet above the level of the junction of the Roy and Spean.

If the last elevation of sixty feet (or thirty, if it be so) which Scotland has experienced, produced elevated sea-beaches, and no proper *river* terraces,—if all the existing river terraces are remains of other sea-beaches, and proofs of other higher elevations,—then another elevation of sixty feet would produce a similar result, and this alone. In order to ascertain the truth, the necessary effects of such a change of level may be briefly reviewed. These effects are as follows:—

1. The formation of elevated beaches, on many parts of the sea-coast, about sixty feet above the sea, varying in height somewhat, as actual sea-shores vary, according to their position with reference to the winds and tides.

2. The beds of rivers being raised, as well as the rest of the land, the amount of descent to the sea would be increased; and, in consequence of this, their waters would run more violently, the excavating force would be augmented, and they would go on with a process of rapid degradation, until the former rate of descent was reached. Towards the mouths of the streams, the bed might be deepened the whole sixty feet. Above, the amount would vary for any given period, according to the ability of the waters in different parts to wear out the material over which they pass. A hard rocky bed might prevent excavation; and, if the material were yielding above such a place, the wear might there level down the surface, and produce a range of slow waters, ending in rapids over the harder unyielding rocks. The amount of excavation might thus vary from sixty feet, the maximum depth, to only a few feet along the tributaries.

3. Besides depressing their beds, the rivers would act laterally, and carry off the alluvium of their banks (when any existed), and every flood would aid in this result, until finally a broad flat, or “bottom-land,” in many places bordered the streams. Such a flat, situated within the reach of the river floods, is common on parts of all rivers where their descent is not too rapid. The breadth of the flat would depend on the amount and force of the waters during floods, and it would necessarily be bounded by a steep slope rising to an upper level. Where the valley was narrow, all the former

alluvium might be carried off; where broad, some portions would be left.

4. The result would be the same, whether the rise were gradual or abrupt. If the latter, the river would have more rending power towards its mouth, and the deepening would go on more rapidly. If a slow, gradual rise should commence at any time, the river, through its increasing excavating power, would begin to sink between its banks, and the wear of the alluvial flat on either side by floods would also commence. The terrace slope would also shew its first beginnings, as an outline to the river flats. Finally, the stream would have a bank of its former height,—this height being a constant quantity for the stream. It would have more or less broad flats, which flats, or bottom lands, would commonly be bounded by a slope; and, if the former alluvium remained, there would be a shelf or terrace above.

5. From the conditions mentioned in the last paragraph, it is evident that, during a gradual elevation (and as gradual a sinking of the stream), the outline of the lower flat might be varied, in consequence of a change in the bed or banks of the stream, which should vary its direction, or the direction of its principal current; and that, therefore, in the course of one and the same rising, a terrace of sixty feet might form in one place, and in another, perhaps not far distant, one of twenty and another of forty; or one of ten, and another of thirty, and another of twenty, and so on. In still other places, the upper alluvial plain might descend by a very gradual inclination to the lower flat; instead of forming a proper terrace, or part-way, it might be gradually declining, and then fall off with the rapid slope that usually bounds a terrace. These are all possible results of the causes mentioned, and are to be looked for in nature.

6. The lakes of the country, where they could at once empty themselves, would correspond with the rivers in the results produced, and each terrace might indicate, in many cases, a separate elevation. When they remained closed by a barrier, they would either gradually become emptied, or by abrupt steps at intervals; and hence there might be several

terraces, differing in height from any along the rivers (indicative of the progress made at successive periods), and differing from those of a neighbouring lake.

7. The terraces of a river without lakes, in the case supposed, would have the terrace-plains approximately parallel with the bed of the stream. Where there were lakes, the terraces would be horizontal, and the stream left in the valley might ultimately have (as in Glen Roy) a rapid descent. It should be remembered, that the descent of large rivers, and, consequently, the corresponding slope of their flats, is *but one or two feet to the mile*; and hence great accuracy in levelling may be necessary to detect a variation from horizontality.

By the way of further illustration, suppose North America to rise sixty feet (or the sea-level to sink this amount). The Mississippi has now a lower flat, in some places exceeding twenty miles in width; on the Ohio the flat is often over five miles; on the Connecticut, over a mile: and so with other rivers. The great river of the west would soon work its bed down the sixty feet. Its banks,—since their height has a relation to the existing level of the river,—would be reduced to their present elevation; and, some miles back, a terrace of sixty feet would mark the limits of the new-formed lower flat. The same result, or something analogous, would take place on the Ohio, and all the other rivers of the country. Even the streamlets that constitute their head-waters, high up among the hills, would each form its terrace where there were proper alluvial shores; for the slope of the whole, from the summit rill to the mouths of the rivers at the sea, would gradually have become increased by the elevation of the country, and the process of excavation would therefore affect every part of the land. There would not necessarily be an identity of height in the terraces formed, for the reasons stated in sect. 2 and 5.

If these are facts,—and who can doubt it,—the formation of every elevated beach along a coast, must be attended by the formation of numberless terraces along the rivers of the elevated country. If so,—for the 60-feet rise Scotland has experienced, there must be river terraces of contemporaneous origin even over the higher lands of the country; every

river will tell the tale as well as the beach along the coast,—if so, the terraces described by Chambers as occurring over these upper regions, cannot all be proofs that the sea there left beaches; and it remains for investigation to establish, by other evidence than the mere existence of such “benches” or “shelves” of land, that any are of that origin. Indeed, the whole work, as far as the subject bears upon the question of elevation, remains yet to be done, excepting the observations relating to the exterior of the island. If there have been elevations of the land corresponding to the sea-shore terraces of 20, 32, 56, 64, 117, 126, 188 feet, there must, for the reasons stated, be traces of river-terraces high up on the land, corresponding to each elevation, making a most complex problem for investigation to unravel. These facts have led to our separating the sea-shore terraces from the others, in the Table given on a preceding page.

8. Another consideration comes in, complicating still more the problem. Suppose the coast to be raised independently of the country back, or to a greater height. This is a possible case, and should be a matter of investigation. It is obvious, that the river excavations would be confined to the parts toward their mouths, and here the terraces would be found. At certain places, the slope of the river's bed would be diminished instead of increased; and in such parts the water would be set back; its bed would fill up; its flats would be flooded more frequently than before, or perhaps constantly, and they would consequently increase in height by new accumulations. Near the sea,—in such a case, the river-terraces might slope with the bed of the stream, while in other places they would be absolutely horizontal, and higher up the valley be wanting altogether.

9. One important conclusion, obvious without farther remark, is, that the terraces in the higher portions of a country are not satisfactory evidences of as many distinct elevations, nor of the actual height of any elevations the country may have experienced. The terraces toward the sea are more trustworthy.

There is a certain rule in the examination of rock deposits—*well understood and generally applied*—which is entirely

neglected by Mr Chambers and many others in the study of terraces. It is this: That the marine origin of a bed is *to be proved* by its resemblance to marine formations, and its containing marine relics. Consider for a moment the characters of a line of coast.

1. In many places above the water-line, there are beach-accumulations; and these accumulations are sandy, and distinctly stratified. The layers, though thin and distinct, are irregular; not of very great lateral extent, but frequently blending and changing their direction. There is often a slope in the layers, having the inclination of a beach.

2. There are drift-heaps on many exposed coasts, formed by the wind and higher seas, above the true beach-accumulations. These also are stratified (or laminated when solidified), each sheet of sand blown over forming a separate layer. The layers are very irregular in dip, often curving (like the top of the drift-heap), and frequently changing their direction. They are often cut off abruptly, and overlaid unconformably by other layers, as a sand-drift is often beheaded by a gale, again to increase by new accumulations. Such drift-heaps sometimes form interrupted ridges along a coast, 40, 50, or 60 feet in height.

3. Below the water level, there are often flats or slopes of gravel, sand, or silt. The material is frequently in delicate layers, and the layers may be of wide or small extent, often (when in extended banks) scarcely varying from horizontality, yet sloping where the bottom slopes. They are frequently rippled by the waves, or agitated into parallel ridges, in some cases even at a depth of 500 feet, and flexures like those of the rippled surface will be apparent in the layers beneath. Again, when the waves on a shore break and flow over a bank in shallow waters, they roll up the sand in a series of slopes: such banks may, therefore, be composed of horizontal layers, while the layers themselves occasionally consist of subordinate inclined layers.

4. The sandy beaches, in some places, contain worn shells; but very frequently they are destitute of such remains, owing to the trituration of the sands destroying those that may be

thrown up. The muddy deposits often afford more or less of animal life of various kinds, and among them shells are common, worn or unworn.

The muddy deposits containing molluscs, and those beach-accumulations that include worn shells, will, together, constitute a certain proportion of a line of coast, and the former a larger proportion of the estuaries. The proportion for any coast should be ascertained, that it may be used as a key towards studying the accumulations over the country back.

5. There is a minimum width for long arms of the sea, which should be compared with the width of interval between opposite terraces or rivers.

Allowing now for a large part to be carried off by waters after an elevation, it is evident that there will still remain, in some parts among sea-coast formations, indications of their marine origin. Such evidence is yet to be found in our upper terraces; and until it is obtained, there is no safety in the inference, that the terraces, extending as they do throughout the interior of a whole country, are marine. It will be time enough to speculate on the facts when they are ascertained. The terraces consist of material of all kinds, from the coarsest pebbles to the finest silt; and, assuredly, the sea, if the source, must have left some traces of itself and its productions, which may be detected where such extensive deposits remain undisturbed.

The writer has observed terraces along the rivers of Oregon and California, as well as in the eastern portion of our country, and for some years has been hoping to take up the subject for special study, feeling assured that a phenomenon which so pervades a continent,—as is evident throughout the United States, from east to west, must afford conclusions of the highest interest to geology. Mr Chambers' work contains much valuable material, shewing at least the wide distribution of terraces over his own country, as well as to some extent in other lands. But more study is required before the great body of the facts he has collected are made available to science. The subject should be entered upon in the manner exemplified by that accurate and laborious Scotch geologist,

MacCulloch,* and carried out with still more minuteness of detail.

1. The heights of the terraces above the bottom of the river-valley on both sides should be measured by careful levelling, and sections should be thus made through the whole course of the stream, from its mouth to its head, at as many places as practicable.

2. The height of the river above the sea, should also be obtained for each place where a section is thus made.

3. The horizontality or slope of the terrace-plains along the valley should be determined; and to this end, the length of any breaks in a line of terraces, met with on the ascent of a stream, should be noted, and the physical features where such breaks occur, in order to understand the causes of them; also the nature of the river's bottom, upon which fact it often depends, whether the terraces may or may not correspond in slope with the existing slope of the stream, and also what may be their height in different places.

4. The relation should be ascertained, if there be any, between the heights of terraces on the smaller tributaries and those of the main stream, or between the stream where the descent is rapid, and where it is nearly horizontal; also between small and large streams in the same vicinity.

5. The character of the deposits, whether alluvial, lacustrine, or of beach or sea-coast origin, applying the tests mentioned, should be matters of thorough investigation. Assuredly, if no marine relics or indications are found along a river's terraces, for one or two hundred miles, it would be defying all geological principles to assert that such deposits were marine.

A river-valley should thus be surveyed from its mouth to the heads of all its tributaries. The Connecticut in our own country affords a most interesting region for investigation; for the terraces are on a magnificent scale, and may be traced, as the writer has seen, even among the White Mountains. One river thus studied, will be a standard of comparison; and

* See Geol. Trans., vol. iv., Pl. 21.

when a whole country has been carefully examined from the shore to its higher summits, we shall have certain and satisfactory data for some grand deductions. We may then hope to learn which terraces belong to one and the same epoch, and to what extent they are measures of the elevations of a country. After these points are determined, we may look for a full elucidation of the former changes of level a continent has undergone during the period included, or perhaps may prove coincidences between distant countries, that will point to some principles in geological dynamics, yet but half acknowledged.

The writer has said nothing upon the effects of glaciers, as they will be better learned from those who have made them their study. The course of investigation pointed out, precedes the application of any theory to account for the facts.

We do not attempt a review of the known facts relating to terraces in this country, since they can establish little more than the general truth of their existence, until a systematic series of observations is carried out.

On the Tides, as Illustrative of Geological Phenomena.

Among the discoveries in science recently made on this side of the ocean, is one which has excited much interest among geologists and navigators; and which seems to us equally to merit the attention of scientific men in Europe. We mean the tide-theory of Captain Davis, recently laid before the Association of American Geologists and Naturalists in Philadelphia. Having had occasion to become familiar with the elements of this theory during a stay of several months this summer on board the vessel commanded by Captain Davis, as the officer superintending one of the divisions of the United States Coast Survey, we thought it might be profitable to publish a sketch of the principal results at which our learned friend has arrived after long and patient investigations.*

The eastern coast of the United States is bordered through-

* Mr Davis is now engaged in preparing a detailed paper on this subject, which will appear in the Transactions of the American Academy.

out its whole extent by a line of sand-banks and islands of very various forms and outlines, but very uniform in their mineralogical character, being composed, for the most part, of a fine white and very quartzose sand. On the coasts of the Southern States (the Carolinas and Virginia), they form a chain of low islands, separated from the coast by a series of lagoons, which give a peculiar character to the navigation of those districts.

Higher up, on the southern coasts of New England, they occur as submarine ridges, parallel to the coast, and separated from each other by wide channels. Farther north these deposits are more extensive, and form vast submarine plateaux, such as the St George's and Newfoundland Banks. Finally, deposits analogous to these are formed at the bottom of the bays, but in a state of more complete trituration. These are known under the name of *flats*.

Mr Davis, after having devoted several years to the study of these various species of banks, has arrived at this result: *that their forms, extent, and distribution, are principally determined by tides*,—the wind and the waves playing but a subordinate part in their formation.

One of the first points on which Mr Davis insists, is the relation that exists between the strength of tides and the distribution of sand-banks. On both sides of the Atlantic we invariably find sand-banks most numerous where the tides are slight, or where their force is exhausted after having been considerable. Mr Davis accounts for this in the following manner:—According to the researches of Mr Whewell, the tidal wave, on entering the Atlantic Ocean, passes onward in the form of an arc, the convexity of which is turned toward the north. In its progress northward, this wave strikes against the coasts of the two continents of Africa and America. From this shock proceed the various local currents, the direction and rapidity of which are determined by the shape of the coasts. Their rapidity is, in general, in proportion to the directness of the obstacles opposing them, and the narrowness of the channels through which they run. These tidal currents, in running with great rapidity along a coast, raise up and carry with them the moveable deposits

and the detritus of all sorts which the waves and atmospheric forces have detached from the beaches. These currents, however, soon lose their force unless new obstacles come in their way; and, in proportion as they abate, the substances held suspended begin to be deposited. Any inequality of the bottom is then sufficient to form the nucleus or point of departure of a sand-bank, the direction of which will be parallel to that of the current. Such, for instance, is the origin of the narrow banks bordering the island of Nantucket, and known under the names of Bass Rip, Great Rip, South Shoal, &c.

But the most favourable conditions for the formation of sand-deposits exist where the tidal current, after passing a promontory, is deflected laterally into a wide bay, where it can expand freely. Not only the heavy materials, but also the more minute particles are then deposited at the bottom of the bay: no longer under the form of narrow ridges, but as broad continuous strata or *flats*, generally composed of very fine sand, or of calcareous mud, where the deposit takes place in the neighbourhood of coral reefs. This is the reason why the most extensive and regular deposits are found at the bottom of wide bays. Cape Cod Bay, on the coast of Massachusetts, is cited by Mr Davis as an example of this mode of deposition.

On the contrary, when the bay is narrow, as the *fjords* of Norway, or when it lies in the direction of the currents, so as to allow the tide to rush in without obstacle, and rise to a great height, as for instance the Bay of Fundy, the ebb and flood are too violent, and occasion too rapid currents to allow the water to deposit any of the materials which it holds suspended. Hence it is that such bays are generally without sand-banks, unless it be in their lateral coves.

A remarkable phenomenon takes place when the tidal current flows with a moderate rapidity along a coast, so as to deposit a bank of sand against the cliffs. In this case, it is not unusual to see the bank stretching out into the sea; but instead of following the direction of the coast, it inclines, from the pressure from without, towards the interior of the

bay, so as to describe a bend, which the seamen of this country call a *Hook*. Sandy Hook, in the Bay of New York, is of this character. Such, also, are the Hook of Cape Cod and the Hook of Holland. The direction of the Hook is invariably that of the current.

The coasts of Europe offer numerous examples of these various forms of alluvial deposits. Lines of narrow banks, like those on the coasts of New Jersey and the Carolinas, have been described by M. Elie de Beaumont, on the shores of France, as, for instance, near Dieppe, and in the department of Finisterre. On the other hand, the Bay of Biscay offers in its sands (which are carried by the winds into the interior, and formed into dunes) a striking example of the bay-deposits. But it is the Netherlands that merit the greatest attention. Sand-banks are rare on the north-west coasts of France; but no sooner do we quit the Channel than we find them scattered throughout the North Sea. Holland itself is in a great measure formed of alluvial sand. Now, these deposits are formed precisely on the spot most favourable to the formation of alluvial deposits, namely, where the tidal current, having passed through the Channel, enters the vast basin of the North Sea. The deposition of sand-banks in the North Sea is favoured, moreover, by the meeting of two tides on the coast of Jutland (one coming from the Channel, and the other passing round the island of Great Britain), forming what the hydrographers call a *tide-node*, which implies, generally, a continual eddy, which is more favourable than anything to the formation of sand-banks.

Considered in their general connection, the alluvial deposits of a continent should be looked upon as the product of a series of currents and eddies alternating with each other, the final result of which is to transport, in the direction of the flood, the moveable materials which the waves and atmospheric agents have detached from the coast-beaches. This is particularly striking on the coast of the United States. The alluvial deposits form, at first, only a narrow line on the coast of Florida; this line enlarges insensibly on the coasts of the Carolinas, Virginia, and New Jersey; it becomes *wider on the coast of Massachusetts*, and finally attains the

maximum of its development in the Grand Bank of Newfoundland.

This process is of the highest importance in the economy of nature, if we consider that the banks thus formed by the tidal currents are the principal seats of animal life in the ocean. It is upon the banks which border the coast of the United States that the most extensive fisheries are carried on (particularly the St George's and Newfoundland Banks), because these are the abodes of those myriads of invertebral animals (worms, molluscs, and zoophytes), which serve for the food of fishes, whilst the great depths of the ocean, at a short distance from the banks, are almost deserts.

The tides are not less important, from the manner in which they influence river-deposits. Hitherto the formation of deltas, such as those of the Mississippi, the Nile, the Orinoco, and other rivers, has been attributed too exclusively to the great quantities of mud which these rivers transport. It seems to be forgotten that other rivers, such as the Amazon, the Rio de la Plata, the Delaware, and others, are not less muddy, and yet, instead of forming deltas at their mouths, they empty into wide bays.

Captain Davis, on the contrary, shews that deltas are in an inverse ratio to the tides, so that they exist only where the tides are feeble or null; whilst we find estuaries wherever the tides are considerable. Take, for example, the rivers of the eastern coast of the United States, and most of the rivers of Europe which empty into the Atlantic Ocean. And this is perfectly natural. The tide, on entering a river, accumulates during the flood, and keeps back the water of the stream, so that when the ebb begins, the water, in escaping, forms a current strong enough to carry off to sea the principal part of the materials held suspended in the river-water. Mr Davis remarks on this point, that, where bars exist in such estuaries, they are generally composed of sea-sand brought by the tide, and not of fluvial deposits.

In connection with Captain Davis, we have endeavoured to apply the above results to the study of the deposits of former geological epochs; and we think it is easy to shew, on a geological chart of the United States, that the same laws which

now regulate the deposition of sand-banks have been in operation during the diluvial, tertiary, and cretaceous epochs; the deposits of these epochs forming so many parallel zones successively following the great backbone of the Alleghanies.

The diluvial deposits, in Europe as well as in America, merit a special attention in this respect. No doubt, during the diluvial epochs, the plains of Northern Germany, as well as a great part of Scandinavia, and, on this continent, the coast of the United States from Florida to Canada, formed a series of banks and shoals, like the banks of Newfoundland in our day, whilst the plains of the west, between the Alleghanies and the Rocky Mountains, formed a vast bay, comparable to the Gulf of Mexico, in which the sea deposited the fine sand and clay of the prairies, as it now deposits in the Gulf of Mexico the sand and mud that border the coast of Texas.

The results of the above researches may be summed up thus:—

1st, The form and distribution of banks, and of alluvial formations in general, are, in a great measure, dependent on tides. They ought to be found everywhere where the tidal current is sufficiently abated to permit the materials held in suspension to be deposited. The finer and lighter materials must therefore be deposited in the calmer places.

2d, The formation of submarine banks is indispensable to the maintenance of animal life, since they constitute the most favourable localities for marine animals.

3d, The formation of deltas at the mouths of rivers is in an inverse ratio to the force of the tide.

4th, The sedimentary deposits of the most recent geological epochs being, in all respects, like the alluvial deposits of our day, we must hint that they were formed under the operation of the same laws.

5th, The form and extent of continents, so far as they are composed of sedimentary deposits, are thus dependent on astronomical laws, that is, on the attraction which the moon and the sun exert, and in all time have exerted on the liquid part of our planet.—(*Desor, in Massachusetts Quarterly Review for December 1848.*)

On the Variations of certain Metalliferous Repositories in Depth. By M. AMEDÉE BURAT.

In a previous memoir,* we have proved the real continuity of mineral veins in depth, in the different classes of metalliferous repositories, at least in regard to the zones accessible to our mining operations. We have obtained this proof by shewing, that in the greater part of cases in which mines have been declared exhausted in depth, this alleged exhaustion was owing to a wrong interpretation of slight accidents, and insufficient examination—to the increasing difficulty with which subterranean works are carried on in proportion to their depth; and, finally, to the frequent changes that take place in the mineralogical nature of the substances.

Many metalliferous repositories, regular and irregular, present us with a composition in their upper parts which becomes modified in depth; those variations which refer at once to the veinstones (*gangues*) and minerals, have been ascribed, in the majority of cases, either to spontaneous alterations or to molecular transportations posterior to their formation.

Accordingly, in all mining countries we observe the fact, of such frequent occurrence, of the alteration of the minerals at the surface, to which the Germans give the name of *Chapeaux de fer*, and which in Cornwall are termed *Gossan*. The most striking feature in this alteration is the colouration of the mass by ochreous tints owing to the decomposition of pyrites, and a general softening of the repository whose argillaceous veinstones (*gangues*) are *rotten*, according to the expression of miners, and the quartzzy veinstones (*gangues*) are *carious* and full of holes.

These modifications are not confined to the surface, but extend to variable depths, often beyond 50, and even in certain cases beyond 100 yards. In these upper regions, the characteristic minerals of repositories are likewise in mineralogical conditions altogether peculiar. Lead veins, for ex-

* See vol. xlv., p. 346, of this Journal.

ample, in which galena is the normal mineral in depth, present us, throughout the whole superior region, with the carbonate and phosphate of lead, frequent or even predominating, the sulphate, arseniate, and chloride, being accidental. Silver, so intimately mingled with the normal galena, is insulated in the state of native silver, in filaments, branching, or dendritic, sometimes in the state of chloride and bromide. The blende seems likewise transformed, and the zinc appears in the state of carbonate or silicate.

The cupriferous repositories are those which present the most complex and most striking differences. Thus, while sulphuretted or pyriteous minerals constitute the normal mineral in depth, the modified region, which may be called that of the gossan, presents us with native copper, earthy or crystalline oxides, hydrosilicates, hydrocarbonates, phosphates, arseniates, and chlorides; minerals remarkable for their beautiful colours, and which thereby give a peculiar aspect to the repositories.

The passage of these minerals belonging to the superior regions into the sulphurets, which exclude them at greater depth, does not take place suddenly. There is always a zone of mixed characters in which the mineral substances are blended. Another character agrees with that of the change of composition in depth, namely, that of structure. In veins, for example, we know that the ribbon structure, that is to say, parallel zones on the roof and walls, is generally observed; but this ribbon arrangement no longer exists in the altered parts of the superior regions, which have always a massive and fragmentary structure without regularity. In irregular repositories and veins not subject to ribbon forms, although the change of the structure in depth be in some measure indefinable, yet we observe it pretty easily because the sulphuretted and crystalline elements of the deeper parts are almost always conjoined with a predominating system of structure. The metalliferous matters are found either in thick zones or in small veins, in drusy cavities, nodules, or lenticular and rounded masses, while the modified parts present nothing but confused masses and irregular impregnations.

Such are the general characters of the variations, of which examples are to be found in all the metalliferous districts. Cornwall, the Vosges, Belgium, the Rhenish provinces, Saxony, the Oural, the metalliferous district of Santiago de Cuba, &c., present numerous types of these modified repositories. The pacos and argentiferous colorados of South America likewise afford examples of metalliferous gossan, and repositories becoming sulphuretted as they increase in depth.

Having had occasion to study a very considerable number of these variable repositories, we were led to doubt whether the differences of composition in the superior parts were really owing to alterations posterior to the formation of these repositories; and we have come to the opinion, after many researches, that, *in a great number of cases, these differences result from circumstances contemporaneous with the formation of the repositories themselves.*

If decompositions induced by atmospheric agents, or by the subterranean waters generally found in empty veins and fissures, which facilitate their circulation by the greater electrical conducting power of veins—if these decompositions originated in the particular state we have pointed out, this particular state would be as general as the causes to which it is attributed. Such, however, is by no means the case; and we can instance entire districts where these decompositions have not reached the metallic sulphurets. In the districts where these superior regions of certain repositories are very much changed, we observe a great number of others which are not so; we even find this divergency of characters in veins which are parallel, placed in juxtaposition, and subjected to conditions absolutely identical.

Thus, for example, Algeria has presented us with a great number of veins, the minerals being either copper pyrites, or grey arseniferous and antimoniferous copper. At Mouzäia, where these veins form, at the surface, very salient walls, these spontaneous decompositions have scarcely reached the cleared parts; the first strokes of the hammer are sufficient to lay bare the sound and metallic portions. In the valley of Oued Boukandah, near Tenès, as well as in that of

Oued Boussoussa, the veins containing the copper pyrites offer it to view immediately, without decomposition, and with a brilliancy which the water running over it often furbishes anew in the bottom of the valleys. The same fact is observed in the veins of the Valley of Chiffa, so that a vein which has undergone those great alterations, of which we have so striking an example in the copper veins of Rheinbreitenbach, has not yet been found in that vast country. In Germany, and even in the very region where this altered vein of the Rheinbreitenbach occurs, we have seen some at a depth of one or two yards from the point where they crop out, in which the copper pyrites, galena, blende, &c., presented themselves immediately, and with all their metallic lustre.

Among the plumbiferous veins whose superior region contains principally the phosphates and arseniates of lead, while galena predominates in their deeper parts, we may mention one of the *zug* veins of Silbach, near Holzappel, in Nassau. This vein still contains a notable proportion of phosphate at a depth of 50 yards; and in its superior part, the phosphate of lead was the principal mineral, while all the other veins of the same *zug* were exclusively characterised by the galena. How could so important an alteration be produced in a single vein out of four in which the physical conditions of exposure to atmospheric agents, and the mode of formation, are absolutely identical? If we compare the vein-stones of the altered vein with those of the others which have undergone no change, we find that the quartz, while compact in the latter, is carious and full of holes in the other; we find that the rocks *des épontes*, and the *épontes* themselves, which, in the sound veins, have nothing particular in them, are, like the quartz, penetrated with green and yellow phosphate, crystalline or earthy. On observing these quartzey veinstones, hard, compact, and well separated from the mineral matter, become, in a single vein, carious, porous, and penetrated with other metalliferous principles; and by studying this energetic action, which has discoloured and penetrated the rocks, *des épontes*, with the same principles, we cannot avoid concluding that so energetic a modifying action had operated upon the

whole of these veins belonging to the same set, and that it is more rational to suppose that the differences of composition are owing to contemporaneous actions which alone could operate with so much force, and with the exception of a single vein.

These anomalies, of which we could multiply examples, must necessarily throw some uncertainty on the theoretical conclusions generally adopted. In order to come to some determination, let us penetrate into the interior of some repositories which may be cited as types of important alteration in the superior parts, and study the details of this alteration.

The vein of Kautenbach, on the right bank of the Moselle (province of Hunsdrück), is, like those of Berncastel, in whose neighbourhood it lies, a plumbiferous vein with veinstone (*gangue*) of quartz. All the superior part of this vein, to a depth which is, at certain points, upwards of 60 yards from the surface, abounds in yellow phosphate of lead, which has long been the normal mineral as well as the galena. The thickness of the compact or crystalline phosphate exceeds at many points 0·60; and, although it is impossible to calculate the quantity of phosphate furnished by this vein from the time when it began to be mined, we may still affirm that it may be reckoned by hundreds of cubic yards. In 1846, very considerable quantities of these phosphates continued to be extracted, although the *chantiers* were 60 yards from the surface, and I could make the following observations on these minerals:—the phosphate was compact, brown or yellowish-white, and furrowed with crystalline drusy cavities, like a sulphuretted mineral. In many places the phosphate was ultimately mingled with galena, and still more frequently the crystals of phosphate from 0^m·005 to 0^m·020 in diameter, perfectly formed, were embedded in the galena. Lastly, the galena was still found in stalactites, covering the crystallised groups of the phosphate, and even the hexædral crystals of galena, were changed into phosphate.

This intimate penetration of the two combinations prevents us supposing that the phosphates of lead are posterior to the galena, and result from its decomposition. Whence could

this enormous quantity of phosphoric acid, not found elsewhere, either in the other minerals of the vein, or in the bounding rocks, have been derived? Is it not more logical to admit that the phosphates have been formed at the same time, and in the same way as the galena, and that they are principally condensed near the surface, perhaps because they were more volatile than the galena which occupied the deeper parts?

Among cupriferous veins, that of Rheinbreitenbach, which we have described in the *Etudes sur les Mines*, will serve as an example of variations of composition in depth. This beautiful vein, composed of compact quartz, has, for its normal mineral, at a level of 120 yards, an intimate mixture of variegated copper and pyriteous copper, while, throughout all the upper part, it was the phosphate of copper that predominated.

These phosphates of the superior regions were mingled with some accidental combinations, such as arseniates, malachite, native copper, and red copper-ore. As we descend, the sulphuretted minerals mix with the phosphated minerals, and at last exclude them. We may have recourse to the hypothesis of a spontaneous decomposition of the sulphurets of the superior region, in the cupriferous repositories of Siberia, where malachite is their substitute; and in the repositories of Santiago de Cuba, where it is native copper and red copper ore; but how can we explain, in this instance, the intrusion of an immense quantity of phosphoric acid into a vein whose composition is so simple?

The quartz which serves as a veinstone (*gangue*) to the phosphated minerals, as well as to the sulphuretted ones, likewise undergoes some variations, which may throw light on these theoretical questions. In the whole region of the phosphates and oxides, this quartz presents calcedonous drusy cavities; and it is in the latter that we find arborescent native copper, and those beautiful red capillary oxides, so much sought after by mineralogists. In the deeper parts, after the sulphuretted minerals have excluded the phosphates, the calcedonous character is eliminated, there are no longer drusy cavities, and the whole filling up consists solely of compact

fissured quartz. Thus, then, to the difficulty of explaining the nature of the transformations of the mineral substance by spontaneous alterations, is joined the impossibility of ascribing to the same origin the partly calcedonous state of the quartz, and the creation of drusy cavities in a substance absolutely compact.

The intervention of water in the phenomena attending the filling up of the superior portion of the vein, is indicated at once by the calcedonous and stalactiform nature of the vein-stone (*gangue*), and by the hydrated composition of the phosphates. Let us, then, suppose this intervention favoured by the proximity of the surface, and, on the contrary, suppressed at some depth by the effect of temperature and pressure, and we shall have made an important step towards a probable theory. The veins, in point of fact, have been assimilated to metalliferous *solfateros*, by which the interior of the globe held communication with the surface, and we may thence conceive how the intervention of water and some other principle could modify the subterranean emanation which determined the filling up.

After having studied these modifications of plumbiferous and cupriferous veins, we should still hesitate to generalise our conclusions, if the calamine repositories of Belgium and Rhenish Prussia did not afford us convincing facts, developed on the vastest scale, expressing with more precision the differences which may exist between the phenomena of the filling up of veins towards the surface, or in deep parts.

The repositories of calamine, situated in highly inclined beds, with anthraxiferous limestones and psammites, or coal-slates, assume very irregular forms. They may be considered as masses *en chapelets*, united to each other by sinuous canals, and very much reduced in section when compared with that of the widely-expanded portions; the horizontal section of the masses sometimes exceeds 50,000 square yards, as at Moresnet and Dos sur la Meuse, while in the canals it often appears reduced below 100 yards. These irregular chimneys, in communication with the subterranean emanations, appear, in certain cases, to have debouched at the surface into a kind of valleys or basins filled with water,

and in which sedimentary formations were at the same time in action. Volcanic *soufflards*, known under the name of *Lagoni*, present us with an existing phenomenon analogous to that which we are now considering. These *soufflards* have their outlet into a depression where lagunes have been formed, and they appear to us as centres of metamorphic alterations, and generations of some particular substances.

Such are likewise the conclusions of a description of many of these repositories, which we have published and illustrated with plans and sections of mines.* Let us consider the variations actually presented by the different substances which constitute the repositories. In the great superficial basins such as those of Moresnet and Dos, we find matters evidently stratified by waters; such are the bole-clays of Moresnet, and the sands of Dos, accompanied with pudding-stones and rolled pebbles of white quartz cemented by calamine. In the repository of Mallieue, and in that of the new mountain near Verviers, these sedimentary products, consisting of sand either pure or mingled with clay and minerals, such as oxide of iron, calamine, and galena, are found at considerable depths, for example to 30 or 40 yards from the surface, and occupy pretty extensive spaces at these levels.

From this composition of the superior region of repositories, in minerals principally oxidated, carbonated and silicated, mingled with evident transported products and sediments produced by the action of waters, the first idea of the miners was to conclude that these repositories were simple superficial *remblais*, which had no continuity in depth. These theoretical notions were very general till the great increase in the manufacture of zinc led to the deepening of the works.

It was then seen that the oxide of iron and calamines of the surface were replaced, as the depth was increased, by an augmenting proportion of pyrites and blende. The galena, which was only in small proportion in the superficial repositories, likewise acquires more importance in the filling up of

* *Etudes sur les gites calaminaires et sur l'industrie du zinc en Belgique.*
(1846.)

the vein. In some mines the substitution is complete. It is now no longer doubted that all the repositories oxidated and carbonated at the surface are transformed in the deeper parts into sulphuretted minerals. Now, if the sulphurets must be ascribed to phenomena acting from below upwards, it is difficult not to suppose the same origin for the carbonates, oxides, and silicates.

This theory being once admitted, it only remains to complete it by explaining the differences pointed out in the composition. In the calamine repositories the explanation is afforded by the very nature of the filling up; all the upper part has been filled under the mingled influences of subterranean and sedimentary actions, while below the inferior emanations have acted exclusively.

The calamine repositories of Silesia, studied by M. Delesse, have suggested analogous ideas to him.

In the Sierra-Morena the repositories of Los-Santos present us with an analogous example. A vein of large dimensions, at least in the upper parts, consists of a mixed composition, in which the phenomena, not of an arenaceous sediment, but of chemical precipitation from a calcareous travertin, has taken as great a part in the filling up as the subterranean emanations which produced spathic iron and copper minerals. (See the Supplement to the *Etudes sur les Mines*.)

From examination of the mines of Chili, M. Domeyko has come to the conclusion that the chlorides of silver, which are abundant at the surface, were replaced below by sulphuretted minerals; and that this modification resulted, not from posterior actions, but from actions coeval with the formation of the repository. The same explanation has been applied to the repositories of argentiferous pacos and colorados of Mexico and Peru, which, in the deeper parts, are transformed into *negros*, that is to say, into sulphuretted minerals.

We conclude, then, that the differences of composition observed in many repositories, when we compare the levels, result from this, that the metalliferous emanations are modified on approaching the surface, under the influence of waters

and other exterior causes, so that these variations ought not to be ascribed to posterior alterations, but rather to the generating phenomena themselves.

We have no desire to extend these conclusions in an absolute manner, by pretending that all the phenomena attributed to spontaneous alteration are erroneous. Even among the examples on which we have founded our observations, the vein of Rheinbreitenbach presents us with many circumstances of alterations and molecular transportations. We find there a cross vein filled with steatitic and basaltic debris, penetrated at its contact with the vein with native copper, which lines its fissures to a distance of many yards. This fact, as well as many other facts of detail, may well be the result of a posterior action. But the great variation of which we have noticed the principal examples, differ completely from these details, and are out of proportion with the causes to which they are ascribed.

The facts here brought forward and discussed, may help further to give us more correct notions of the general theory of metalliferous veins. They shew us the results of subterranean emanations, becoming modified more and more as we remove from the seat of the generative actions, so as to form, according to Elie de Beaumont's observations,* zones of a different nature.

Thus the sulphuretted or oxidulated, and perhaps native minerals, form the lowest zone with which we are acquainted, which sometimes shews itself at the surface, under the form of eruptive repositories; to these minerals we assign as a character a compact state and homogeneousness in the mass. We find these characters very prominently marked in the eruptive oxidulated iron of the Island of Elba, and in that of Taberg, in Sweden: we find them in the pyrites and other minerals contained in the amphibolites of Tuscany and Norway. The native metals contained in the traps are always in a compact state, and are, in this respect, distinguished

* Geological Society, meeting of 3d July 1847.

from the native metals of *the surface*, which are in crystalline dendrites and capillary filaments.

A second zone is characterised by the crystalline and *geodic* state of the same minerals, by the mixture and variety of species, and variety of veinstones (*gangues*). This zone comprehends almost all the veins. The repository of Rio, in the Island of Elba, so eminently crystalline, likewise belongs to this second zone. The crystallised pyrites, falherz, galena, blende, red silver, &c., of the Hartz, Saxony, the Rhine, &c., belong to this category of formations produced by sublimation. The state of the minerals, in fact, reminds us of that of matters brought into existing craters by steam; and this zone presents us with the emanations of the subterranean masses of the preceding zone.

Lastly, on approaching the surface, we find the phosphates, muriates, arseniates, the native crystalline or capillary metals, and the earthy oxides of the Chapeaux de Fer; minerals which constitute a third zone, as distinctly characterised as the preceding.

We have not such data as enable us to determine the comparative thickness of these different zones. The inferior zone appears to us to have, in some measure, an indefinite thickness, which cannot be measured; the intermediate zone has never been traversed, and works of 800 yards in depth, carried on in certain veins, have brought to light no variation which indicated the proximity of the mineral substances of the inferior zones. With regard to the superior zone, 50 yards would be nearly a medium, and 100 yards a maximum. Its thickness, therefore, is very slight compared with that of the two others; and it is not of great importance to us, further than that it is the first which presents itself to our investigations.

This slight degree of thickness in the zone of superficial minerals, ought necessarily to draw attention to the fact of its general preservation, which is such that we can recognise, on the present surfaces, the existence of basins in which the metalliferous repositories, whose formation is anterior to the chalk, have mingled their products with those of sedimentary

actions. We must infer from this preservation of the superior phenomena, that in many cases the revolutions of the surface of our globe have been greatly exaggerated, since such frail monuments of subterranean actions on the surface have reached our day in a state of preservation often complete. The superficial metalliferous repositories are therefore new proofs to be added to those which M. Elie de Beaumont has brought forward respecting the conservation of continental surfaces.—(*Annales des Mines*, t. xiii., p. 235.)

Notice of a Flood at Frastanz, in the Vorarlberg, in the Autumn of 1846. By WILLIAM BROWN, Esq. Communicated by the Author. 45

The action of running water,—in dissolving and rubbing down the solid parts of the earth's surface,—in transporting these from one place to another,—and in finally depositing them in the bed of the ocean, or in some other level lower than their original site, is known to all. We are ready, however, to overlook the extent to which this process is going on, and the rapidity with which it is altering the relative levels of sea and land. Rapidity appears an unsuitable word, when we compare merely the events of individual years, or of a single lifetime; but when we add up the results of many years, and compare the observations of a succession of observers, it is in no respect improper.

A large river becomes swollen, or a mountain-burn is "in speat." It is no longer the bright transparent stream which it previously was; but with its increased volume, it has also become "drumly," that is, it has washed down from its upper banks a quantity of the soil, which it holds in suspension, while it flows rapidly on. As the motion becomes slower, however, it gradually deposits the coarser part, and carries to the sea or other resting-place, only the finer and lighter particles. This process is repeated to a greater or less extent after every heavy shower of rain, but more evidently in spring, at the melting of the mountain snows, and in the

autumnal months, after the usual rains at that period. Some solid matter is washed into the current, and deposited somewhere at a lower level; and as this takes place on every stream in every part of the earth's surface, we are assured, that should the same causes be permitted to act during a sufficiently long period, the time will certainly arrive when the ocean shall overflow the present dry land, its own basin having been filled up with the debris.*

The effects produced are not always of the gradual character now referred to. Sometimes large masses of the banks are quickly overwhelmed and carried down the stream. The materials are removed to no very great distance; but still their position has been changed, and the loss of cohesion enables the water to remove them much farther than would at first have been supposed. Many such occurrences have been recorded in the annals of past times, and many more have been described in recent periods, since the attention of men has been called to such things. When a bridge is overturned by the force of the current, part of the materials are carried down the stream to a great distance. When a river leaves its accustomed channel, and cuts out a new one for itself, the solid matter which formerly occupied the place now held by water, has been carried down far from its former site.† We cannot read many pages of such a work as Sir Thomas Dick Lauder's *Account of the Morayshire Floods*, without seeing ample proof of the power of running water to remove to a great distance even stones. Of large size, of course, rounded

* The causes which are now elevating the land in several districts are local and variable. The action of running water is universal and unceasing.

† Mr Lyell says,—“The power of even a small rivulet, when swollen by rain, in removing heavy bodies, was lately exemplified in the College, a small stream which flows at a moderate declivity from the eastern water-shed of the Cheviot Hills. Several thousand tons weight of gravel and sand were transported to the plain of the Till, and a bridge then in progress of building was carried away, some of the archstones of which, weighing from half to three-fourths of a ton, were propelled two miles down the rivulet. On the same occasion the current tore away from the abutment of a mill-dam a large block of greenstone porphyry, weighing nearly two tons, and transported it to the distance of nearly a quarter of a mile.” This was in 1829.—*Principles of Geology*, vol. i., p. 254.

stones, or boulders (bowls, as the country-people call them), will move more easily, and therefore to greater distances. I have no intention of indulging in further remarks of a general character, my purpose being to give a short notice of an example of this kind, but with some unusual circumstances, which occurred, under my own observation, in the autumn of 1846, when I resided for some weeks in the Vorarlberg.

The district to which the name of Vorarlberg is given, is popularly considered as part of the Tyrol. This is not, however, strictly correct, for it has a separate political existence as a province, and is divided from North and South Tyrol, by the mountain-ridge called the Adlerberg. It forms the north-western frontier of the Austrian empire in Germany, having as its neighbours, Bavaria, Wirtemberg, and Switzerland. The surface extent of the province may be about 47 German, or about 200 English square miles. Its population is about 120,000. A considerable portion consists of one side of the great Rhine Valley, of the valleys which open into it, and of the subordinate valleys which open into these. It is thoroughly a mountainous region, but none of the heights exceed 5000 feet above the Lake of Constance, which is, however, between 2900 and 3000 feet above the ocean. There are mountains 8000 feet higher in the immediate neighbourhood of the province. The inhabitants are generally of an industrious and peaceful character. Few of them are of great wealth, but there is little of abject poverty. The land is extensively subdivided, but not as yet to an extent that is injurious. The peasants cultivate their own lands, and frequently one or more of the family are engaged in a trade, or work at one of the cotton-mills which have recently sprung up under the fostering care of the Austrian government. The scenery, although wanting the magnitude of Tyrol proper, yet is of an interesting character. The broad valleys are covered with numerous small, but rich fields of Indian corn, potatoes and hemp. The lower mountain-sides have frequently thriving vine-rows, and always fruit-trees; and in every part we see those rich grassy slopes, dotted with the rude but substantial *hay houses*, which form so striking a feature in Swiss scenery. *Luxuriant forest-trees* occupy the higher ridges, and now and

then, but not very often, a crag appears, relieving by its grey colour the unvarying green which surrounds it.

The Ill is a river of some importance in this province, and, after a course of about forty miles, flows into the Rhine, near Feldkirch. A short way above this town it rushes between two nearly mural precipices, of 300 feet high. Ten or eleven miles above this point, it passes through a similar but much wider opening; and the intervening space is a valley of varying breadth, sometimes of three miles, surrounded by mountains of moderate height. The perfect level of most parts of this valley indicates that it had, at one time, been the bed of a lake; and the occurrence, at various points, of perfectly flat surfaces, 10 or 12 feet raised above the general level of the valley, lead us to infer that the lake had once, at least, been partially emptied, before the rocky barrier near Feldkirch had been completely burst through by some overpowering force.

The mountain-sides of this valley of the Ill do not form a continuous boundary, but smaller streams descend on either side, through openings of various characters. Some are narrow ravines, or *tobelns*, as they are called, while others open out into wide spaces, having their villages and cultivated fields around them. There is not a great deal of bare rock to be seen: the steep sides are sometimes bare, like what are called "scaurs" in the south of Scotland. The soil, in the level of the valley, is rich and deep; that on the mountain sides is usually rather shallow, and covers over, in every part, a thick bed of gravel. Wherever the upper bed of earth has been removed by the elements, or by the industrious operations of the people, this gravel comes into view.

The summer of 1846 was as hot and dry in the Vorarlberg as in other parts of Europe. When I arrived, in the middle of August, there had been no rain for many weeks, with the exception of a few thunder-showers, hasty in their appearance and in their departure. All the crops were abundant (excepting the potatoes, which were nearly destroyed), and much earlier than in ordinary seasons. On the evening of the 20th of August, rain began to pour, and, out of the *twelve succeeding days*, only one was entirely fair; while,

during seven, the rain was nearly continuous. Every one said that there had been no such rain for many years. The usual consequences followed, the lowest valleys were flooded, roads were rendered impassable, and more than one bridge was carried away by the force of the current. The chief injury was not done to the banks of the Ill itself, but it was the subordinate valleys which suffered most. At the village of Sattaens, a rapid stream had brought down a great mass of earth, gravel, and stones, which completely overlaid some gardens and fields, and altered considerably the public road. But Frastanz, on the opposite side of the valley, was the chief seat of the mischief, and to this I must now advert more particularly.

Frastanz is a small village upon the left side of the valley of the Ill. A small stream, sufficiently large to turn the machinery of a cotton-mill (consisting of 8000 spindles), after a circuitous course among the mountains, empties itself into the Ill, a very little way below the village. This village is about two miles above Feldkirch, near which is the rocky boundary of the great original lake. The houses are partly built upon the mountain-slope, and partly upon the nearly level part of the valley. Mr Gamahle's mill is a well-built stone edifice of three or four stories, at the lowest part of the village, and where the ground is very nearly level. My first visit to the village was on the 6th of September, when the rains had ceased for nearly a week. We found numerous groupings of people from the neighbourhood who had come, as we had, to see the strange state of things. We first found that the bridge, by which the public road was carried across the rivulet, had been raised very considerably, and the road was steepened accordingly. The bridges in this district, even those over the large rivers, are all of wood. The water had spread itself over a wide surface, and was flowing with not a very violent current over a broad channel. So far, I had often seen in our own country, rivers, when in flood, covering all the level haughs with their discoloured water. But here the stream was bright and transparent, nearly as in its usual state, and was evidently flowing at a higher level, not so much from the volume of water being much augmented, as because

its bed was elevated. Looking at the current itself, one could not have considered it dangerous, either from the mass of water, or from the rapidity of its motion. In almost every part it could be crossed on foot. But the villagers were in a state of great apprehension, and several hundred men, partly soldiers, partly peasants, were actively engaged in various operations. The stream was flowing on the top of a mound of gravel, which, in one place, was 25 feet high. It was banked in by large pine trees freed from their branches, and laid lengthwise. These were supported by thick stems driven into the gravel perpendicularly, and in places where it was necessary, the pine branches formed an interlacing. The chief place of danger seemed to be the cotton-mill, along the gable of which the stream was flowing several feet above the floor. The mill had ceased working for several days, the canal leading the water to the great wheel at the opposite gable having been choked with the gravel brought down by the stream. This had been again and again cleared out, but at length the contest was abandoned. One or two other houses higher up in the village were also threatened, but all the exertions of the people were directed to the mill.

I was at Frastanz again on the 11th, and also on the 13th. At the latter date the height of the stream was three feet more than it was on the 6th, a week before. Of course the bridge had been repeatedly raised, and the roadway across it was very uncomfortable from its steepness. By looking narrowly into the stream, it was evident that stones were rolling along. You could follow the course of individual stones; and what was seen in these individual instances, you were sure was doing in millions of other instances. It was indeed a torrent of gravel and rounded stones, none of which were of less size than a small egg.

The landslip of gravel, which had caused this remarkable phenomenon, occurred seven miles up the stream. It was presumed to be the consequence of a practice much more common now than formerly,—of cutting down a great many trees together on the steep banks. In the course of time the stump and all its roots decay, and become little channels for the rapid transmission of water. Were only some of the trees

cut down, and were young trees put in the place of those removed, their fresh and vigorous roots would bind the soil together; but when the only roots are decaying ones, the occurrence of heavy rain fills these numerous canals, and the weight at length separates the superincumbent mass from the gravel bed beneath.

On the 17th I again passed through the village. The gravel still flowed, although in smaller quantity. On the 23d, when I saw it for the last time, the flow of gravel had very much ceased. The danger to the mill and other houses was considered to be over for the time; but there was entertained an apprehension that, unless the gravel were removed, when the spring floods came down, serious injury would take place. A letter of 2d November 1846, gave me the following information: "The water at Frastanz has already worked wonderful changes since you were here. At the bridge, the old channel has reappeared, but there is still a tremendous mass below. A wooden channel has been constructed, at great expense, from the Ill towards Gamahle's mill, to confine the water, and carry off the stuff; and has so far done excellent service, although the stream has broken through more than once."

A letter, dated 20th January 1848, describes the present state of matters: "The mass of gravel and stones brought down has been, perhaps, one-third washed down into the Ill, by means of a wooden canal constructed on purpose, but which is now, to a great extent, filled and buried. The channel of the Ill has been raised by the stuff so brought down, as far as Feldkirch, several feet; and there are immense masses of loose stones and gravel still above, to an extent of several miles up the ravine, which, sooner or later, must be washed down, and threaten to renew the catastrophe at any time. Another and smaller, but wild mountain stream, 'the Gallina Bach,' between Nestying and Frastanz, which crosses the main road, has this year been playing the same game, and has brought down, and kept in constant motion for weeks together, a mass of gravel with scarcely any visible way which is scarcely credible to one who
 b it. At some distant period this stream has

done the same, and covered, to a depth of 50 feet, a surface of at least 100 acres. The same causes as in Frastanz, though operating more slowly, have set it again a-going; and there seems every probability of its compelling a total change in the line of road, as there is scarcely any human possibility of stemming such a heavy torrent of debris, pouring through a narrow gorge, from mountains 5000 feet high, on either side of a ravine six or eight miles at least in length. The 'Saminer Thal,' behind Frastanz, runs ten or twelve miles back to the mountains bordering on the Grisons, and some of which are from 6000 to 8000 feet above the level of the sea, or 1600 less above that of the valley of the Ill, where the stream discharges itself close to Carl Gamahle's mill."

Palæontological Notes. By HERMANN V. MEYER.*

Holzerweid, near Bussenhausen, in the canton Zurich, must now be added to the localities in Switzerland in which the diluvial Löss contains remains only of the *Elephas primigenius*, as Herr A. Escher von der Linth has sent me some teeth of this animal of a calcined aspect from that place. More importance attaches to the occurrence of this elephant in the diluvial slate coal, which much resembles brown coal, at Dürnten, a league from Rapperswyl, where a large molar tooth has been found of a brown colour, like walnut wood, and thus very similar to teeth from the tertiary brown coals. This coal deposit represents the oldest diluvial filling-up of the valleys in the Swiss Alps, and contains plants which Heer was not able to distinguish from those now living in moist places in Switzerland. Near Utznach, this slate-coal furnished the tooth of a large ruminant resembling the deer. The occurrence of *Elephas* in this situation reminds me of a mammoth skeleton dug out at Troïtskoë, near Moskau, and described by Rouillier. The upright position in a marsh, in which the animal was found, shews distinctly that it had been buried in the mud when venturing too far on the soft

* Leonhard and Bronn's Jahrbuch, 1848, p. 465; and Geological Quarterly Journal, No. 17, J. N.

ground in search of food. The formation at Moskau also consists of a fine laminated mass resembling brown coal, containing fishes, infusoria, and plants of species still living in the neighbourhood. I would also draw attention to an observation recorded in my *Palæontologica*, p. 540, according to which the *Elephas* occurred, with remains of the ox, stag, fishes, shells, and plants, in a turf-like diluvial bed at Wittigendorf, near Sprottan. All these places are only the natural abodes of the ancient elephant, where it found its food, consisting of species of plants, which were not distinct from those that still flourish in these localities. Such facts refute the groundless hypothesis that the remains of elephants were transported by great floods from distant regions to the places where they are now found; or that the species was only enabled to exist in them by the influence of external causes, or great changes in climate. They also testify to the truth of a view which I have long adopted, that there is some internal cause of this phenomenon, through which, even in historical times, the extinction and geographical distribution of species have been limited. Goldfuss, in his work on the *Archegosaurus*, describes the skull of an animal from the stone coal-formation of Heimskirchen near Kaiserlautern, which he names *Sclerocephalus*, as that of a fish. It seems to me to have more the resemblance to that of the Labyrinthodonts than even the *Archegosaurus*, and, consequently, may as well as this genus be added to the Saurians.

Professor E. Schmid of Jena has recently entrusted to me his whole collection of fossil vertebrate animals from the muschelkalk of that district. To it were added two new species of ammonites from the celestine strata in the lower muschelkalk at Wogan; one of them is a very beautiful species, which I have named *A. (Ceratites) Woganensis*. It is nearest the *A. (ceratites) enodis*, Quenst., but is smaller, and the back is not arched but acute, thus giving a different character to the sides; it is perfectly smooth, and even the sutures do not agree with those of the species compared with it.

The remains of saurians in this collection formed a very acceptable addition to my "Monograph of the Saurians of the Muschelkalk." Previously, I only knew from the vicinity of Jena those remains which Count Münster had received

from Professor Schmid's own collection. The muschelkalk saurians of Jena were mostly of small dimensions; but one rib bespeaks a large animal. The collection contains the humeri, almost the most important bone, of eight smaller species, belonging to more than one genus, and the large rib indicates a ninth species. Formerly I knew no humerus from the muschelkalk in which the foramen for the passage of the ulnar artery was wanting; but this is the case in one of the Jena bones, a circumstance hardly accidental, as the bone otherwise indicates a peculiar species. A humeral bone in the collection of Count Münster also shews the existence of another species, so that there are at least ten saurians in the muschelkalk of Jena; and among these humeri there is scarcely one that agrees with the bones from Upper Silesia or other localities in this formation. The coracoid bones in Schmid's collection, belong to six species, now others are found in that of Count Münster, and this bone in the large species is still wanting; so that the coracoid bones from Jena also point to the existence of nine species, most of them distinct from those of other districts. These collections contain the scapulæ of four small species, the femoral bones of three species, and the pelvic bones of at least four species; all, as well as the small vertebræ, shewing no complete agreement with the bones from Upper Silesia or other countries. The teeth resemble those of the Nothosaurus. Labyrinthodonts as yet are entirely wanting. Besides these, there has been found, in the bone-beds of the muschelkalk of Wogau, the humerus of two species, but not distinct from those of Jena; in the Wellenkalk (lower muschelkalk) of Lobedaburg, a tooth of a small species, formed like that of the Nothosaurus; in the bone breccia of the muschelkalk of Keilhau, near Rudolstadt, vertebræ of a very small species; in the terebratula limestone of Zwetzen, a bone of the pelvis; in the highest beds of the muschelkalk at Mertendorf, three leagues from Jena, a humerus; and in the Keuper limestone of Vieckberg, near Apolda, a large nothosaurus-like tooth.

The fishes from this district, with those from Querfurth and from Upper Silesia, will be described by me in one of the early numbers of the "*Palæontographica*," the plates being already lithographed. Besides scales, and an unim-

portant fragment of the jaw of a small fish with cylindrical teeth, the proper muschelkalk of Jena has only furnished the *Saurichthys tenuirostris*, of which Agassiz (*Pois. Foss.*, ii. b., p. 88) incorrectly states, that it only occurs in the muschelkalk of Bavaria, where it is entirely unknown. It is confined to Jena, and occasionally occurs also at Querfurth, from which the specimen was derived which Büttner long ago figured (*Rudera testis diluvii*, 1710). The glauconite muschelkalk of Mattstädt, near Apolda, contains teeth of *Saurichthys Mougeoti*. More important is the terebratula-limestone of Zwetzen, containing teeth of *Placodus*, which, besides *Placodus gigas*, seem to have belonged also to another species. The most interesting specimen from Zwetzen is a jaw with several teeth of a new genus of fish also of a large size, which, from the dome or cupola-like form of the top of the teeth I have named *Tholodus*, and this species *Tholodus Schmidii*. It is best placed near *Acrodus*, though the teeth are wholly distinct.

In the "Athenæum" for June 5, 1847, Sir R. Murchison has published a letter of Agassiz from America, in which he expresses his astonishment at the analogy which exists between the types of life in the temperate regions of North America and those in the molasse of Oningen. He believes, consequently, that these deposits were formed in a climate that was not tropical, and in this comparison he also introduces Japan. These are exactly the same views that were already published in my work on "Fossil Mammalia, Birds and Reptiles, from the Molasse Marls of Oningen," which work Agassiz knew before his journey to America. In that work I have not only pointed out the close relation which the tertiary Oningen, without renouncing its European character, still bore to the present North America and Japan; and also came to the conclusion that the tertiary creatures of Oningen required for their existence a climate not at all warmer than that which now prevails in the region of Oningen, so that the assumption of a tropical climate in which the animals of the molasse have lived, is anything but well founded.

In Tayler's museum at Haarlem, which I visited in August 1847, I saw the beautiful remains of the *Mastodon* found at Oningen, which belong to the *Mastodon angustidens*. In this

collection there are also some species of vertebrata not hitherto known to occur in that place, and the first specimen which I saw in the rich collection of Professor van Breda, was a new rodent from *Oningen*, to which I have given the name of *Scuirus Bredai*. In Tayler's museum I saw also the *Anguisaurus* from the lithographic slates of Solenhofen, assuredly a most remarkable creature, and well deserving a thorough description, which, however, would require more time than I can command. It seems related to the *Pleuro-saurus*, of which I have the middle portion of the skeleton before me, and perhaps the two genera may come to be united.

Whilst residing on the coast of the North Sea in Holland and Belgium, I thought myself transported to the very workshop where the marine molasse and the shell sandstone of the molasse were forming before my eyes. The dunes are an analogous formation; the sand of the dunes is the molasse sand of historical times; the similarity is so remarkable that it only requires consolidation, in order to represent the molasse sandstone with its contents, which would consist of living instead of extinct species. The sand of the dunes rarely envelopes molluscs in a living state; it is chiefly the shells of dead animals, and these for the most part fractured, broken into fragments, or rubbed by the incessant beating of the waves. The beach seen during the ebb may be compared to a great extent of exposed strata, on which remains of organisms appear in various places. Even the flame-like distribution of colours and other markings, on the divisional surfaces of rocks, may be partly explained by the deposit of foam from the waves. The manner in which the waves during the ebb of the retiring sea sport with the fine sand on the beach is very interesting. They give it a wave-like, variously-furrowed arrangement, resembling the sculptured markings on the skull of the crocodile. Similar appearances, and no less regular, occur on the surface of many rocks containing petrifications. The sea-shore may also convince us that many phenomena in the fossiliferous rocks have their cause in the alternation of the seasons, a phenomenon which *must be carried further back in the history of the earth than*

our theorists imagine. When it is considered, for example, that the immense profusion of fish on the shores of the Netherlands, in summer declines to absolute poverty, many of the fish then seeking other littoral regions, we may conceive that the variation in the numbers of petrifications which the strata of one and the same formation present, the alternation of highly fossiliferous beds with others in which fossils are rare, or entirely wanting, that the interruptions in the occurrence of species by beds in which they do not appear, as well as the diversity in fossils which is observed when, in wide-spread formations, the same stratum is followed to distant points, may in part be explained by the alternation of seasons. On the strand, newly exposed by the retiring sea, at the season of my visiting it, I rarely found a fish; it was chiefly molluscs, sea-stars, among them often those with four rays, prawns, and among plants fucoids, that were left behind. In a sand-hill I found the shell of a crab full of the fine sand, and in the best way to become a petrification. Even the more frequent occurrence of cetacea in certain parts of the molasse formation is explained by the fact that at present there are particular parts of the sea-shore where cetacea are very frequently stranded; Ostend is such a locality. These whale-like animals are often thrown on shore; among others, the monster which, after going the tour of Europe as a curiosity, is now found at St Petersburg.

Address Delivered by the President (Sir J. F. W. HERSCHEL, Bart.) on presenting the Honorary Medal of the Astronomical Society to William Lassell, Esq., of Liverpool.

GENTLEMEN,—The Report of the Council having been read, in which the astronomical discoveries of the year, and especially that of the planet Metis, have been clearly and eloquently commemorated, it is now my pleasing duty to state to you the grounds on which it has been agreed by us to award the gold medal of the Society for this year to Mr Lassell. And this duty, pleasing in itself, I execute with the greater satisfaction, because I have a sort of hereditary fellow-feeling with Mr Lassell, seeing that he belongs to that

class of observers who have created their own instrumental means—who have felt their own wants, and supplied them in their own way. I believe that this greatly enhances the pleasure of observing, especially when accompanied by discovery, and gives a double interest in the observer's eyes, and perhaps, too, in some degree, an increased one in those of the public, to every accession to the stock of our knowledge which his instruments have been the means of revealing: upon the same principle that the fruit which a man grows in his own garden, cultivated with his own hands, is enjoyed with a far higher zest than what he purchases in the market. Nor is this feeling by any means a selfish one. It arises from the natural and healthy excitement of successful exertion, and is part of that happy system of compensation by which Providence sweetens effort, and honours well-directed labour. If this be true of the labour of a man's hands in the mere production of material and perishable objects, it is so in a far superior sense, when the faculties of the intellect are called into exercise, and works elaborated with rare skill, and wrought to an extraordinary pitch of perfection, have yet a higher, ulterior, intellectual object, to which their existence is subordinate, as means to an end.

Mr Lassell has long been advantageously known to us as an ardent lover of astronomy, and as a diligent and exact observer, in which capacity he has appeared before us, as a reference to our Memoirs and Notices will testify, on numerous other occasions besides those to which I shall more particularly call your attention presently. In the year 1840 he erected an observatory at his residence near Liverpool, bearing the appropriate name of Starfield, which has ever since been the scene of his astronomical labours. Even at its first erection this observatory features of novelty and interest. In addition to a good transit, it was furnished, instead of a meridian instrument or an ordinary equatorial achromatic, with a Newtonian reflecting telescope of nine inches aperture, and rather more than nine feet in focal length, equatorially mounted, the specula of which were of his own construction, and the mode of mounting devised by himself. This was already *a considerable step*, and forms an epoch in the history of the *astronomical use of the reflecting telescope*. Those only who

have had experience of the annoyance of having to keep an object long in view, especially under high magnifying powers, and in micrometrical measurements, with a reflector mounted in the usual manner, having merely an altitude and azimuth motion, can duly feel and appreciate the advantage thus gained. But the difficulties to be surmounted in the execution of such a mode of mounting were very considerable—much more so than in the case of an achromatic,—owing partly to the non-coincidence of the centre of gravity of the telescope and mirror with the middle of the length of the tube, and partly to the necessity of supporting the mirror itself within the tube in a uniform bearing free from lateral constraint, and guaranteed against flexure and disturbance of its adjustment by alteration of its bearings. These difficulties, however, Mr Lassell overcame: the latter which is the most formidable, by an ingenious adaptation of the balancing principle, first devised, if I am not mistaken, by Fraunhofer and Reichenbach for the prevention of flexure in the tubes of telescopes—a principle which has not received half the applications of which it is susceptible, and which, by throwing the whole strain of the weight of instruments on axes which may be made of unlimited strength, may be employed to destroy the distorting force of gravity on every other part.*

The success of this experiment was such, and the instrument was found to work so well, that Mr Lassell conceived the bold idea of constructing a reflector of two feet in aperture and twenty feet in focal length, and mounting it upon the same principle. The circumstances of his local situation, in the centre of manufacturing industry and mechanical construction, were eminently favourable to the success of this undertaking; and in Mr Nasmyth he was fortunate enough to find a mechanist capable of executing in the highest perfection all his conceptions, and prepared, by his own love of astronomy, and practical acquaintance with astronomical obser-

* As, for example, the divided limbs of circles, and the spokes connecting them with their centres; an easy and simple mechanism, which, devised some time ago, and approved by the late M. Bessel, I may, perhaps, take some future opportunity to submit to the Society.—(Note added in the Printing.)

vation and with the construction of specula, to give them their full effect. It was of course, however, the construction and polishing of the large reflector which constituted the chief difficulty of this enterprise. To ensure success, Mr Lassell spared neither pains nor cost. As a preliminary step, he informs us that he visited the Earl of Rosse, at Birr Castle, and besides being favoured with more than one opportunity of satisfying himself of the excellent performance of that nobleman's three-foot telescope, enjoyed the high privilege of examining the whole machinery for grinding and polishing the large speculum, and returned so well satisfied as to resolve on the immediate execution of his own ideas.

The mode of casting and grinding the mirror, differing in some of the details, though proceeding generally on the same principle as Lord Rosse's (*i. e.*, by a chilled casting), has been described in a communication read to this Society on the 8th of December last. The polishing was performed on a machine almost precisely similar to that of his Lordship. But finding, after many months' trial, that he could not succeed in obtaining a satisfactory figure, he was led to contrive a machine for imitating, as closely as possible, those evolutions of the hand by which he had been accustomed to produce perfect surfaces on smaller specula. This machine has been described (and a model of it, as well as Mr Nasymth's finished working drawings of it, exhibited) in a paper of great interest read at the last meeting of this Society, of which also an abstract has been printed in our Notices, and must by this time be in the hands of every Fellow here present, so that it cannot be necessary for me to recapitulate its contents. Suffice it to say, that I have carefully examined both the drawings and the model, and having myself had some experience in the working and polishing of reflecting specula, approaching (though inferior) in magnitude to Mr Lassell's, I am enabled to say, that it seems to unite every requisite for obtaining a perfect command over the figure; and when executed with that finish which belongs to every work of Mr Nasmyth, from the steam-hammer down to the most delicate product of engineering and mechanical skill, cannot fail to secure, by the oily smoothness and equability of its move-

ments, the ultimate perfection of polish, and the most complete absence of local irregularities of surface. The only part which I do not quite like about it, or perhaps, I should rather say, which seems open to an *à priori* objection, refutable, and, in point of fact, refuted by the practical results of its operation, is the wooden polisher, owing to the possibility of warping should moisture penetrate the coating of pitch with which it is (I presume) enveloped on every side. Some unhygrometric, non-metallic substance, such as, for instance, earthenware, porcelain biscuit, or slate, would be free from this objection, though possibly open to others of more importance.

Both Mr Lassell and Lord Rosse appear to be fully aware of the vital importance of supporting the metal, not only while in use, but also while in process of polishing, in a perfectly free and equable manner; but the former has adopted a mode of securing a free bearing on the supports, by suspending the mirror, which is a great and manifest improvement on the old practice of allowing it to rest on its lower edge, by which not only is the figure necessarily injured by direct pressure, but the metal is prevented from playing freely to and fro, and taking a fair bearing on its bed. As I have, however, on another occasion enlarged on the necessity of making provision against these evils, by a mechanism almost identical in principle, I need not dwell upon this point farther than to recommend it to the particular attention of all who may engage in similar undertakings.

It is right that I should now say something of the performance of the nine-inch and two-feet reflectors. And first, as regards the success of the system of mounting adopted in securing the peculiar advantages of the equatorial movement. This appears to have been very complete. The measurements, both differential and micrometrical, made with them, and recorded in our Notices, shew that, in this respect, they may be considered on a par with refractors, and in facility of setting and handling they appear nowise inferior. Of the optical power of the former, two facts will enable the meeting to form a sufficient judgment. With this instrument Mr Lassell, independently, and without previous knowledge of

its existence, detected the sixth star of the trapezium of θ Orionis. And with this, under a magnifying power of 450, and in very unfavourable circumstances of altitude, both himself and Mr Dawes became satisfied of the division of the exterior ring of Saturn into two distinct annuli, a perfectly clear and satisfactory view of the division being obtained.

The feats performed by the larger instrument have been much more remarkable and important. It has established the existence of at least one of the four satellites of Uranus, which since their announcement by Sir W. Herschel had been seen by no other observer, viz., the innermost of all the series, and afforded strong presumptive evidence of the reality of another, intermediate between the most conspicuous ones. The observations of M. Otto Struve, if they really refer to the same satellite, are of nearly a month later date.

To Mr Lassell's observations with this telescope we also owe the discovery of a satellite of Neptune. The first occasion on which this body was seen was on the 10th of October 1846, but owing to the then rapid approach of the planet to the end of its visibility for the season, it could not be satisfactorily followed until the next year, when, on the 8th and 9th of July, observations decisive as to its reality as a satellite were made, and in August and September full confirmation was obtained. This important discovery has since been verified both in Russia and in America. I call it so, because, in fact, the mass of Neptune is a point of such moment, that it is difficult to overrate the value of any means of definitively settling it. Unfortunately, the exact measurement of the satellite's distance from the planet is of such extreme difficulty, that up to the present time astronomers are still considerably at issue as to the result.

I come now to the most remarkable of Mr Lassell's discoveries, one of the most remarkable, indeed, as an insulated fact, which has occurred in modern astronomy; though, indeed, it can hardly be regarded as an insulated fact, when considered in all its relations. I need hardly say that I allude to the discovery of an eighth satellite of Saturn, a discovery the history of which is, in the highest degree, creditable, not only to the increased power of the instruments

with which observatories are furnished in these latter days of astronomy, but also to the vigilance of observers. If I am right in the principle, that discovery consists in the certain knowledge of a new fact or a new truth, a knowledge grounded on positive and tangible evidence, as distinct from bare *suspicion* or *surmise* that such a fact exists, or that such a proposition is true—if I am right in assigning as the moment of discovery, that moment when the discoverer is first enabled to say to himself, or to a bystander, "*I am sure that such is the fact,—and I am sure of it for such and such reasons,*" reasons subsequently acquiesced in as valid ones when the discovery comes to be known and acknowledged—if, I say, I am right in this principle (and I really can find no better), then I think the discovery of this satellite must be considered to date from the 19th of September last, and to have been made simultaneously, putting difference of longitude out of the question, on both sides of the Atlantic. In speaking thus, I desire, of course, to be understood as expressing only my own private opinion, and in no way as backing that opinion by the authority of the Society whose chair I for the moment occupy. The Astronomical Society receives with equal joy the intelligence of advances made in that science, from whatever quarter emanating, and accords the meed of its approbation to diligence, devotion, and talent, with equal readiness, wherever it finds them; but declines entering into *nice* questions of personal or national priority, and would, I am sure, emphatically disavow the assumption of any title to lay down authoritatively rules for the guidance of men's judgments in such matters. The medal of this day is awarded to Mr Lassell, not on account of this discovery alone, and as such, but as taken in conjunction with the many other striking proofs he has afforded of successful devotion to our science, both in the improvement and in the use of instruments. And among the motives which have induced your Council to place Professor Bond on the list of our associates (I trust not long to be the only one of his countrymen by whom that honour is enjoyed), though this discovery has had its due and just weight, we have not been unheeding of his *general merits*, both as an observer and as a theoretical astro-

nomer—merits of which the Memoirs which have recently reached us, convey the most abundant evidence in both departments.

I have observed that, when taken in all its relations, the discovery of an eighth satellite of Saturn cannot be regarded as quite an insulated fact. Between Iapetus and Titan there existed a great gap unfilled, in which (as formerly between Mars and Jupiter) it was not in itself unlikely that some additional member of the Saturnian system might exist. The extreme minuteness of Hyperion forcibly recalls the analogous features of the asteroids, and it would be very far from surprising, if a farther application of the same instrumental powers should carry out this analogy in a plurality of such minute attendants.

Mr Lassell, as you are all well aware, is bound to astronomy by no other tie than the enjoyment he receives in its pursuit. But in *our* estimation of his position as an amateur astronomer, it must not be left out of consideration, that his worldly avocations are such as most men consider of an engrossing nature, and which entitle them, in their moments of relaxation, as they conceive, to enjoyments of a very different kind from those which call into fresh and energetic exertion all their faculties, intellectual and corporeal. It is no slight and desultory exercise of those faculties which will enable any man to carry into effect so much thoughtful combination, and to avail himself with so much consecutiveness of their results when produced. And however we may and must acknowledge that such a course of action is really calculated to confer a very high degree of enjoyment and happiness, we ought not to feel the less gratefully towards those who, by their personal example, press forward the advent of that higher phase of civilization which some fancy they see not indistinctly dawning around them; a civilization founded on the general and practical recognition of the superiority of the pleasures of mind over those of sense; a civilization which may dispense with luxury and splendour, but not with the continual and rapid progress of knowledge in science and excellence in art.

I think I should hardly be doing full justice to my subject,

or to the grounds taken by the Council in the award, if I were to conclude what I have to say otherwise than in the pointed and emphatic words of a report officially embodying the prominent features of the case. "The simple facts," says that document, "are, that Mr Lassell cast his own mirror, polished it by machinery of his own contrivance, mounted it equatorially in his own fashion, and placed it in an observatory of his own engineering: that with this instrument he discovered the satellite of Neptune, the eighth satellite of Saturn, and re-observed the satellites of Uranus. A private man, of no large means, in a bad climate" (nothing, I understand, can be much worse), "and with little leisure, he has anticipated, or rivalled, by the work of his own hands, the contrivance of his own brain and the outlay of his own pocket, the magnificent refractors with which the Emperor of Russia, and the citizens of Boston, have endowed the observatories of Polkowa and the Western Cambridge."

The President then, delivering the medal to Mr Lassell, addressed him in the following terms:—

And now, Mr Lassell, all that remains for me is to place the medal in your hands, and to congratulate you on your success and on the noble prospect of future discovery which lies before you, now that, free from the preliminary labour of construction, your whole attention can be devoted to using the powerful means you have created. In the examination of the nebulae, in the measurement of the closest double stars, and the discovery of others which have hitherto defied separation—in the physical examination of the planets and comets of our own system, there is a wide field open, and the sure promise of an ample harvest; and I can only add, that we all heartily wish you health and long life to reap it.

On the Motion of the Glacier of the Pindur in Kumaon. By
Lieutenant R. STRACHEY, Engineers.

In No. 181 (August 1847) of the Asiatic Society's Journal, I gave an account of the glacier at the head of the Pindur

River, in which it was noticed that I had been unsuccessful in an attempt to measure directly the motion of the glacier. In the past month (May 1848) I again visited this glacier, chiefly with the intention of making an accurate measurement of its motion; and the result of my operations I now propose to detail:

About 200 yards below the small tributary that enters the main glacier from the north-west, an old moraine, grown over with grass and bushes, which vouched for its present stability, offered a convenient station from which the motion of the ice could be observed. The moraine is heaped up against an almost perpendicular wall of rock, sufficiently high to command a view of the greater part of the surface of the glacier along the line on which observations were to be made. This line, which is nearly perpendicular to the general direction of the glacier, was marked by two crosses painted white, one on the rock in contact with the old moraine, the other on a cliff on the opposite side of the valley. A stake was driven into the moraine, at its highest point, close to the rock on the line between the two crosses, and a theodolite was set up over it. Five other marks were also made on the glacier, at intervals along the same line, by fixing stakes in holes driven in the ice with a jumper. These marks, which were all carefully placed on the exact line between the crosses by means of the theodolite, were completed at about 0^h 30^m P.M., on the 21st May.

On the following day the theodolite was again set up on the same place as before, and being properly adjusted, the cross wires of the telescope were directed to cross on the cliff on the opposite side of the glacier. A stick was then set up near the first of the five marks that had been made the previous day, and was, by means of signals, moved up or down the glacier, till it appeared to coincide exactly with the cross wires of the telescope, and consequently to be exactly on the line between the two crosses painted on the cliffs. The distance between the centre of the stick and that of the fixed mark was then measured, which evidently shewed the downward progress of the ice at that point of the glacier

since the marks were made the day before. The same process was repeated at each of the other marks.

On the 25th May the progress of the fixed marks was again measured in exactly the same way. The results of these measurements are as follow:—

Time of Observation.	Distances of fixed marks from standard line.									
	On the west moraine.		On the medial moraine.		At east foot of medial moraine.		Near the middle of the clear ice.		On the eastern moraine.	
H. M.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
21st May, 0 30 P.M.										
22d May, 1 15 P.M.	0	5½	1	0¼	1	0	1	0¼	0	6¾
25th May, 8 45 A.M.	1	9½	2	9¾	2	11¾	3	1	1	5½

The motion in twenty-four hours of the several marks will also be found to be—

Date.	Mean motion of ice in 24 hours (in inches).					
	On the west moraine.	On the medial moraine.	At east foot of medial moraine.	Near the middle of the clear ice.	On the east moraine.	Approx. mean Temperature.
21st to 22d May	5·3	11·9	11·6	11·9	6·5	43° F.
22d to 25th May	5·7	7·6	8·4	8·8	3·8	38° F.
General mean	5·5	9·7	10·0	10·3	5·1	

The progress of the lower extremity of the glacier was likewise approximately measured by observing the apparent angular motion of a pole fixed on the top of the eastern mo-

rairie, and of a conspicuous rock lying not far from the middle of the glacier.

The results of these observations are:—

Date.	Mean motion of ice in 24 hours (in inches).	
	On the moraine.	Near middle of glacier.
19th to 20th May	3·0	...
20th to 23d May	6·2	8·1
23d to 25th May	5·3	10·8
General Mean	4·8	9·4

The comparison of the motion of the lower and upper parts of the glacier is:—

	Mean motion of ice in 24 hours (in inches).	
	On the lateral moraines.	On the middle of the glacier.
Lower part of glacier	4·8	9·4
Upper part of glacier	5·3	10·0

At the time of my visit to the glacier hardly any of the last winter's snow remained on its surface. The weather, which was tolerably fine up to the 22d May, after that day became very bad. Besides a good deal of rain, about 3 inches of snow fell on the 23d, and as much on the 24th, and on the morning of the 25th, the clearer parts of the upper end of the glacier were still covered with snow, though it *had melted on the moraines and open ground near the*

glacier. This bad weather appears to have had considerable effect in retarding the motion of the ice.

I may as well here mention that the motion of the Mer de Glace, as measured by Professor Forbes, varied from 27 to 9 inches in 24 hours, in different parts of the glacier, and at different times between the months of June and September. The motion of the middle part of the glacier of the Aar is also stated by M. Martins to be about 71 mètres per annum, which amounts to about $7\frac{1}{2}$ inches in 24 hours.

The elevation of the foot of the glacier, where the Pindur leaves it, determined by the comparison of corresponding barometrical observations, made there and at Almora (5586 feet), is 11,929 feet above the sea. The elevation of the station where the theodolite was fixed to measure the motion of the glacier, was similarly found to be 12,946 feet; and the elevation of the surface of the glacier near its lower end, at a distance of about 6000 feet from the theodolite station, being about 12,140 feet; the slope of the surface of the glacier is about $7\frac{1}{2}$ degrees.—*Journal of the Asiatic Society of Bengal*, No. xx., p. 203, New Series.

The Gum Kino of the Tenasserim Provinces. By the
Rev. F. MASON.

In a valuable article by Dr Royle on Gum Kino, reprinted in the *Journal of the Agricultural and Horticultural Society of India*, which ostensibly enumerates all the various regions from which it has been imported into England, there is no mention of this article being imported from this coast. Yet long before Dr Royle compiled that communication, more than one consignment had been made by parties in Maulmain to houses in London of gum kino to the amount of a thousand pounds.

It was brought to Maulmain by an English merchant from the Shan States, and stated by him, as our Commissioner at the time informed the writer, to be the production of the *Pa-douk*, the same tree as the one in Maulmain thus de-

nominated by the Burmans. Several years before I had directed attention to this tree, as producing an astringent Gum, resembling Gum Kino; but the medical officer to whom I submitted specimens of the gum, said it was "a kind of dragon's blood;" but after it was known that the gum of the Pa-douk had been sold in London for the veritable Gum Kino, another medical gentleman tried in his practice the exudation of the tree in his compound, in place of the Gum Kino in his stores, and reported the effects the same; that their medical virtues were alike.

The next inquiry that arises is for the genus and species of the Pa-douk. When I first came to the coast, all the English residents of my acquaintance called it "Burman senna," and the surgeon of the station told me that he believed it was a species of senna. The Rev. H. Malcolm, D.D., President of Georgetown College, Kentucky, who came out to India a dozen of years ago, in order to go back again and write a book, has stereotyped in his travels, "Pa-douk, or mahogany (*Swietenia mahogani*), is plenty in the upper provinces, especially round Ava, found occasionally in Pegu. In a native Pali dictionary, found in the Burmese monasteries, Pa-douk stands as the definition of *Pe-tâ-tha-la*, and the corresponding Sanscrit word in Wilson's dictionary is defined, Pentaptera; but the Pa-douk does not belong to that genus. In Piddington's index, however, Peetshala stands as the Hindoo name, and in Voigt's catalogue, Peet-sal, as the Bengalee name of *Pterocarpus marsupium*; and this brings us nearer the truth, for Pa-douk is a name common to two different species of *Pterocarpus*, but which look so much alike, that they are usually regarded as one species. Undoubtedly, one species is *P. Indicus*, and the other, I presume, is the one named by Wight, *P. Wallichii*, but which was marked in Wallich's catalogue, *P. Dalbergioides*, from which it differs in no well-marked character, excepting that the racemes are axillary and simple, while in that they are terminal and "much branched." Wight says of *P. Wallichii*, in his Prodrômus, "stamens all united or split down on the upper side only;" so they are sometimes in our tree. In the figure that he gives in his Illustrations, they are represented as diadel-

phous, nine and one, and so they are seen occasionally in our tree; but the more common form is that of being split down the middle into two equal parts of five each, as in *P. Dalbergioides*. The wood, too, resembles it. "Not unlike mahogany, but rather redder, heavier, and coarser in the grain." It is often called "red wood" at Maulmain; and from the colour of the wood, some of the natives distinguish the species, "red Pa-douk" being *P. Dalbergioides* and "white Pa-douk," *P. Indicus*.

Both these trees produce an astringent gum, which has been exported for Gum Kino, or whether it was a mixture of both it is not possible to say. Probably the latter, as the native collectors would not probably make any distinction; possibly it is the production of neither. It may be that *P. marsupium* is found in the Shan States; for it grows, I believe, in Assam, and the man that did not distinguish the two species in Maulmain, would not distinguish them from a third at Zimmay. Be that as it may, this is certain, that these provinces can furnish the commercial world with a large quantity of Gum Kino. If the result of the experiment which was made be correct, we have a great abundance of it within our own borders, for the Pa-douk is one of the most common forest-trees in the provinces from the Tenasserim to the Salwan. It furnishes a considerable portion of the fuel that is sold in Maulmain. But if not, it is certainly abundant in the neighbouring provinces, whose only avenue to market is through our territories.—*The Journal of the Asiatic Society of Bengal*, No. 20, p. 223.

On the Physical and Geographical Distribution of the Birds of Ireland.

The least reflection will convince any one who appreciates the geographical distribution of species, that the birds of Ireland are, in this respect, even more interesting than those of Great Britain, as, within its latitude and longitude, Ireland is the "ultima Thule,"—the extreme western limit to which the European species, not found in the western hemi-

sphere, resort. The geographical position of the island also renders it occasionally the first European land on which North American species, after having crossed the Atlantic, alight.

Considerable differences, too, consequent on physical causes, will be found to exist in the economy of the same species in Great Britain and Ireland.

The *physical geography*, or natural features of the country, compared with those of Great Britain, cannot be said to deprive Ireland of more than one species (the *ptarmigan*). The relative proportion, in the two countries, of land to water, of heaths and bogs, to cultivated grounds and plantations, has influence only on the number of individuals.

Nor does the difference in the *mineralogical structure* of Ireland, compared with Great Britain, affect the actual presence of any species, although it is the primary cause which influences the number of individuals prevailing in different parts of the island. The plants which appear on particular soils attract such land birds as feed upon their seeds. The submarine rocks and grounds, on which sea-weeds grow plentifully, so as to afford shelter to the minute fishes, and the molluscous cretaceous animals on which the wading and swimming birds feed, tempt them in greater numbers to the neighbouring shores. The oozy, the sandy, the gravelly, the stony, the rocky beach, has each its favourite species, as has every peculiar natural or artificial feature of a country, from the level of the sea to the most lofty mountain summit.

The difference in *climate* between Ireland and Great Britain, cannot be said to deprive the former island of any species found in the latter. The comparative mildness of winter in the more western island has, however, great influence on birds. Even in the north of Ireland, a few land species, considered as birds of passage in England, except in the *extreme* south, become resident; and some grallatorial birds remain throughout the winter; although found only in the south of England at this season. The soft-billed birds also, being generally able to procure abundance of food, are, by the comparatively high temperature, more inclined to song at this *period of the year*. The *humidity* of the climate, together

with the great extent of bog throughout the island, brings hither to winter different species of grallatorial and other birds, in much greater numbers than prevail in England or Scotland. The extent of moist and rich meadows in summer, has a similar but more limited influence. The want of extensive districts of *old timber* seems, when fully considered, to have little effect in excluding from Ireland species which inhabit Great Britain.

To the laws of *geographical distribution* alone must, I conceive, be attributed our want of species not affected by any of the foregoing causes,—viz., physical geography, mineralogical structure, climate, and absence of old timber. It should be borne in mind, that in all the preceding remarks, the mere absence or presence of *species* is considered; consequently, nothing is said of birds, from different causes, being less frequently met with in Ireland than in particular parts of England or Scotland. Such points will be fully treated of under the respective species.

Although, in their polar and equatorial migrations, the crossing of a sea,—as the Mediterranean for instance,—offers no obstacle to birds, yet is it different when they are spreading latitudinally, either to the east or to the west, in which case the migration of many species terminates at the margin of the sea. Were Ireland, therefore, geographically joined to Great Britain, some species that are not now found would certainly inhabit it, but the junction would make no difference with respect to others,—resident as well as migratory birds. In that event we should, in the east of Ireland at least, have those species which are found throughout the most western portion of Great Britain, in the same parallel of latitude; but not those whose range of distribution does not extend to the most western counties of England and to Wales. The species which Ireland would and would not have, under such circumstances, may be inferred from an examination of the summary appended to the end of each order of birds, where the distribution over Great Britain, of the species not known as Irish, is pointed out. We should, for example, if the country united them, have, as resident birds, *the green woodpecker* and *the nuthatch*; of annual summer

migrants, the wood-wren and the tree-pipit. But we should not have the stock-dove,—a resident species in the midland and eastern counties of England; nor would the melodious nightingale favour us with its presence; so definitively marked is the line of its migrations. As to other species, which are found, though rarely, to the westward,—in Cornwall and Wales,—as the lesser white-throat, &c., they might then, as a matter of course, be expected as rare visitants; such they possibly may be now, though more unfrequently than they would be in the other instance.

In like manner, the junction of Great Britain throughout its parallels of latitude, with the nearest continental land, would add greatly to the number of British birds, that island being as deficient comparatively in those of the most western European countries, as Ireland is in comparison with it. The sea lying between the shores of Great Britain and the Continent, has the same effect as that extending between the former and Ireland. Were there an island even of equal size to Ireland, situated as far distant to the westward of that country as it is from Great Britain, the diminution of species would be still greater than that actually existing between Ireland and Great Britain, and so on, in an increased ratio, were island after island, about equidistant from each other, placed still farther to the westward.

The falling off would be owing to the principle that species continue diminishing (each within its different range) the farther we recede from their metropolis, and that the diminution is accelerated by the insular nature of the land, as opposed to its being conterminous or continental.

The preceding remarks apply only to islands like Great Britain and Ireland, lying near a continent, and deriving their birds thence. There are, however, instances of islands situated sufficiently near large continents to admit of the flight of birds from the latter, and yet deriving comparatively few, or none of their species from them. The most remarkable example is presented by the *Galipagos archipelago*, situated under the equatorial line, and which, though only 500 to 600 miles westward of the coast of South America, does not contain a land bird from the continent. Even some of

the islands of the group have their peculiar species. Full information on this most interesting subject will be found in Mr Darwin's excellent Journal, kept during the Surveying Voyages of H.M.S. Adventure and Beagle, vol. iii., p. 461, and 473-478. Madagascar, the nearest part of which is only about 250 miles distant from the coast of Africa, and extending about 1000 miles in a parallel direction, offers another striking instance of an island not deriving its fauna from the neighbouring continent. Of 113 known species of birds of Madagascar, 68 are peculiar to it. The fullest information on the subject of the ornithology of that island will be found in a comprehensive essay, by Dr G. Hartlaub of Bremen, published in the Annals of Natural History for Dec. 1848, p. 383-396. For a knowledge of it, and its translation from a German journal, the English reader is indebted to Mr H. E. Strickland.

It is interesting to observe how birds are affected by the operations of man. I have remarked this, particularly at one locality near Belfast, situated nearly 500 feet above the sea, and backed by hills rising to 800 feet. Marshy ground, the abode of little else than the snipe, became drained, and that species was consequently expelled. As cultivation advanced, the numerous species of small birds attendant on it became visitors, and plantations soon made themselves inhabitants of the place. The landrail soon haunted the meadows, the quail and the partridge the fields of grain. A pond, covering less than an acre of ground, tempted annually for the first few years, a pair of the graceful and handsome sandpipers (*Totanus hypoleucos*), which, with their brood, appeared at the end of July or beginning of August, on their way to the sea-side from their breeding haunt. This was in a moor about a mile distant, where a pair annually bred, until driven away, by drainage rendering it unsuitable. The pond was supplied by streams descending from the mountains, through wild and rocky glens, the favourite haunt of the water-ouzel, which visited its margin daily throughout the year. When the willows planted at the water's edge had attained a goodly size, the splendid kingfisher occasionally visited it during autumn. Rarely do the water-ouzel

and kingfisher meet "to drink at the same pool;" but here they did so. So soon as there was sufficient cover for the water-hen (*Gallinula chloropus*), it, an unbidden but most welcome guest, appeared and took up its permanent abode; a number of them frequently joining the poultry in the farm-yard at their repast. The heron, as if conscious that his deeds rendered him unwelcome, stealthily raised his "blue bulk" aloft, and fled at our approach. The innocent and attractive wagtails, both pied and grey, were, of course, always to be seen about the pond. A couple of wild ducks and two or three teal occasionally, at different seasons, became visitors; and once, early in October, a tufted duck (*Fuligula cristata*) arrived, and after remaining a few days took its departure, but returned, in company with two or three others of the same species. These went off several times, but returned on each occasion with an increase to their numbers, until above a dozen adorned the water with their presence. During severe frost the woodcock was driven to the unfrozen rill dripping into it beneath a dense mass of foliage; and the snipe, together with the jack-snipe, appeared along the edge of the water. The titlark, too, visited it at such times. In summer, the swallow, house-martin, sand-martin, and swift, displayed their respective modes of flight in pursuit of prey above the surface of the pond. The sedge-warbler poured forth its imitative or mocking notes from the cover on the banks, as did the willow-wren its simple song. This bird was almost constantly to be seen ascending the branches and twigs of the willow (*Salix viminalis* chiefly) that overhung the water, for *aphides* and other insect prey. In winter, lesser redpoles, in little flocks, were swayed gracefully about, while extracting food from the light and pendant bunches of the alder seed. Three species of tit (*Parus major*, *cæruleus*, and *ater*), and the gold-crested regulus, appeared in lively and varied attitudes on the larch and other trees. In winter, also, and especially during frost, the wren and the hedge-accentor were sure to be seen threading their modest way among the entangled roots of the trees and brushwood, little elevated above the surface of the water.

So far only the pond and bordering foliage have been con-

sidered; many other species might be named as seen upon the trees. On the banks, a few yards distant, fine Portugal laurels tempted the greenfinch to take up its permanent residence, and served as a nest during the winter for many hundred linnets, which made known the place of their choice, by congregating in some fine tall poplars that towered above the shrubs, and thence poured forth their evening jubilee.

To name all the birds that cultivation, the erection of houses,* the plantation of trees and shrubs, together with the attraction of a garden, brought to the place, would be tedious. It will, therefore, only be further observed, that the beautiful goldfinch, so long as a neighbouring hill-side was covered with thistles and other plants, on the seeds of which it fed, visited the standard cherry-trees to nidify; and the spotted fly-catcher, which particularly delights in pleasure-grounds and gardens, annually spent the summer there. Of the six species of British *Merulidæ*, the resident missel and song-thrushes, and the blackbird, inhabited the place; the fieldfare and redwing, winter visitants, were to be seen in their season; and the ring-ouzel, annually during summer, frequented an adjacent rocky glen; curlews, on their way from the sea to the mountain-moor, occasionally alighted in the pasture-fields. The entire number of species seen at this place (seventy-five English acres in extent), was seventy; forty-one or forty-two of which bred there. A few others,—the kestrel, ring-ouzel, sand-martin, and quail,—built in the immediate neighbourhood.

Nearly seventy species have been noticed in Kensington Gardens, London.† White remarks, that Selborne parish alone has exhibited at times (120 species) more than half the birds that are ever seen in all Sweden. The parish comprises an extent of thirty miles in circumference; and where else, within the same inland area, should we hope to find so

* Including houses in the category may seem inadvertent. But the house-martin annually built about the windows or under the roof of the dwelling-house; as the sparrows did in the spouts; the swallow against the rafter of sheds, and the swift in apertures at the caves; the thrush, redbreast, and wren also occasionally nidified in the outhouses.

† Yarrell.

many, as amid the seclusion of that little earthly paradise, with all the "kindly aspects, and sloping coverts," portrayed in the pages of its amiable historian. By drawing a circuit of thirty miles around Belfast, and its most populous neighbourhood (the boundary line being a mile and a half inland from the town, and eight miles and a half seaward, so that the opposite verge may include the greater portion of the bay), we shall find that at least 185 species have been seen within it, some of them, too, possessing very high interest. Within that circle have appeared the first individuals of several species placed on record as visiting Ireland, and the only examples of three species yet obtained, namely, the spotted redshank, the flat-billed sandpiper, and the surf-scooter. Within the limited circle of thirty miles, alighted in 1802, the first white-banded crossbill (*Loxia bifasciata*) known to visit Europe, its native country being Siberia; nor for many years afterwards was the species observed in Great Britain, or in any country of continental Europe. Indeed, within the last few years only has it been distinguished from a nearly allied North American bird. Within the same range occurred the only individual of the Bonapartian gull (*Larus Bonapartii*) yet ascertained to have migrated to Europe, the species being a native of North America, and common in the fur countries, &c. Within that area was also obtained the first fork-tailed gull (*Larus Sabini*), known to wing its way southward, not only to temperate climes, but towards the continent of Europe; and being a young bird of the year, it appeared in a garb in which the species had never before come under the notice of the naturalist.

But to return to the remark of White, respecting the parish of Selborne producing more species than the half of those found in all Sweden, it must be observed, that as a general rule the number of species bears no comparison to the area; thus, there are in the parish of Selborne 120 species, within the same space around Belfast 185, in Ireland 262, in the British Islands generally 320,* in Europe

* Jenyns in 1843; several species since added.

503,* in North America 471,† in Australia 636,‡ in the world 5000.‡

The neighbourhood of Belfast, including the Bay,§ may be considered too fully dwelt upon throughout this work; but what is alluded to in this locality should, unless mentioned as of a local nature, be viewed in the light of an epitome of the general habits or economy of the species. Notes, which may seem too fully given, are interesting in a statistical point of view, as the rapid changes made by man on the material world, affect birds to a great extent. Nowhere is this more required than in connection with the place just named, as railways lately constructed on both sides of the bay, have diminished to a great extent the feeding ground of the *Grallatorial* and *Natatorial* birds. Interesting peculiarities respecting the locality, and the changes effected, will be found noticed under curlew, and other species. The great increase of shipping of late years, and the steam-vessels in particular, have already had great effect upon them. The swivel-guns, too, tell a deadly tale. The adjacent Strangford Lough, owing to its comparative retirement, is becoming annually more and more resorted to by birds which would otherwise remain in Belfast Bay. But on this subject, the following information on species, at particular periods, is given, that we may judge of the changes which have taken place, either as to their decrease or as to their increase. Those which have *decreased in number* shall be first considered. According to the *Topographia Hiberniæ* of Giraldus de Barri (Cambrensis), written towards the end of the twelfth century, the crane was very common in Ireland, about a

* Prince Canino's Comparative Catal., Birds, Europe and North America, 1838.

† Gould's Introduction to Birds of Australia, 1848.

‡ Strickland, Report on Ornithology, British Association Reports, 1844, p. 218. It has been lately remarked that, although this is about the number accurately known, there may be in the world 6000 species.—(*Agassiz and Gould's Principles of Zoology*, p. 3, 1848.)

§ The plate in Hawker's Instructions to Young Sportsmen, &c., entitled "Approaching Wild-Fowl preparatory to the Flowing Tide," gives a good idea of the gulleys, as they are called, of Belfast Bay.

hundred being sometimes seen in a flock. If the bird meant by that author were the true crane (*Grus cinerea*), and not the heron (*Ardea cinerea*), commonly called by that name in Ireland to the present day, the stately bird would seem to have been once as common here as it was in early times in England. The latest published record of its occurrence in this island known to me, is that of Smith, who, in his Histories of Waterford (1745) and Cork (1749), remarks, that a few were seen in those counties during the great frost of 1739. They are mentioned as birds of passage, which do not breed; and in the former work are said not to have been seen "since or before, in any person's memory." Two instances of the occurrence of single individuals in Ireland in the present century will be found noticed under the species in the present work. That noble bird, the cock of the wood (*Tetrao urogallus*), was plentiful throughout the native forests of Ireland, but has long since become extinct, the last bird having been killed about a century since. The great bustard (*Otis tarda*), too, an inhabitant of the open plain, disappeared about the same period.

In "A brife Description of Ireland made in this yeere 1589, by Robert Payne," it is stated,—“There be great store of wild swannes, * * * much more plentiful than in England.” Harris, in his History of the County of Down, published in 1744, remarks of the wild swan (*Cygnus ferus*): “Great numbers of them breed in the islands of Strangford Lake,” p. 233. In another part of the volume it is observed:—“Four of these islands are called *swan* islands, from the number of swans that frequent them,” p. 154. That these fine birds built there at so comparatively late a period may seem doubtful; but it should be borne in mind that Low, in his Fauna Orcadensis, written at the end of the last century, informs us that “a few pairs build in the holms of of the Loch Stennes,” in Orkney.* Ruttty, in his Natural History of the County of Dublin, published in 1772, observes:—“There are two sorts (of ‘wild goose, *Anser ferus*’),

* No date is given; the author died in 1795. His work was not published until 1813.

the one a bird of passage, that comes about Michaelmas and goes off about March; but there is a larger kind, which stays and breeds here, particularly in the Bog of Allen," vol. i., p. 333. Harris, in his *History of Down*, speaks of the "great harrow goose being found in a red bog in the Ardes near Kirkiston," but says nothing of its breeding there. An octogenarian friend has, however, informed me, that a relative often told him that he had robbed the nests of wild geese in this very locality, Kirkiston flow—red bog of Harris;—the period of his doing so was previous to the year 1775. There is little doubt that the true wild goose (*A. ferus*) was the bird alluded to, as it formerly bred plentifully in the fens of England, though for a considerable period they, as well as the bogs of Ireland, have been deserted by it.

The golden eagle is becoming annually more rare, and is now even "very scarce" in its former stronghold, the county of Kerry. The kite, remarked by Smith, in his *History of Cork* (1749), to be so common as to "need no particular description," and to remain "all the year," has been known in the present century only as an extremely rare visitant to any part of the island; this species would be affected by the absence of wood. The bittern, on the other hand, affected by the draining of bogs, has almost ceased to breed in Ireland, though it commonly did so throughout the island, until a late period. It now ranks as little more than an occasional winter visitant, from more northern countries. The curlew, golden plover, lapwing, and others, have been driven from many of their breeding grounds by the drainage of the bogs; as has the shell drake from many rabbit-burrows, which are no longer retired, owing to the increase of population. This has likewise influenced the whimbrel to change its haunts around Belfast, where, until the last forty or fifty years, it regularly frequented the pastures, including the upland ones, during the few weeks of its sojourn when on migration northwards. Of late years, it has been seen only on the sea-shore; pastures and bogs seemed to be its favourite places of resort in spring. The total disappearance of the beautiful goldfinch and bullfinch, from districts which they had regularly frequented, the varying increase and decrease of the swallow

tribe, partridge, &c., will be found treated under the species, as will be the great increase and decrease of the black-headed gull, at particular localities.

It is not on the land only that changes have taken place. Wigeons, in consequence of being too much disturbed in Belfast Bay, by increase of shipping, steam-vessels, &c., even by night—their feeding time—have greatly diminished within the last twenty years. Previous to that period, they arrived here every evening at twilight, in vast numbers from Strangford Lough, and after remaining to feed during the night, again retired every morning before daybreak, to the comparative quietude of its waters. Morning and evening, shooters took their station on the hill-tops, over which the birds often flew within shot; but, of late, such “occupation’s” gone. Similar changes respecting others of the *Anatidæ*, and also of the *Grallatores*, will be found under the respective species. The beautiful and graceful roseate tern has nearly, if not wholly, disappeared within the last few years from a favourite annual breeding-haunt, the Mew Island, at the entrance of Belfast Bay, the result, I grieve to say, of wanton cruelty. Persons go to the island every summer to shoot these birds, and the closely allied arctic and common terns, while they have their eggs or young. Should one even of a different species be brought to the ground, while the others are a little distant, they make common cause, wheel down towards their fallen comrade, as if to compassionate its fate, and are even at such times “savagely slaughtered.” The shooters have no object in view, but the heartless one of using as targets these beautiful and innocent creatures, which are afterwards flung away as useless.

Other birds have *increased in number* of late years; the most striking example of which, for a regular and steady augmentation, is the missel-thrush. The long-tailed tit has also become gradually more plentiful; the extension of plantations is accessory to this end, in respect to both species. The singular increase of snow-buntings during a few winters will be found noticed; as will that of crossbills in recent years. Allusion to the rapid multiplication of the magpie, from the period of its introduction to the island, must not be omitted. The fact of the starling having deserted the town of Belfast

as a building haunt, for perhaps forty years, and two or three pair returning again last season, is singular. The increase in the number of quails wintering of late years, and in the number of woodcocks remaining through the summer to breed in favourite localities, is worthy of record.

A great deal more might be stated, in these general terms, on the subject of the increase and decrease of species. But it is hoped that sufficient has been said to denote the desirableness of our possessing full and accurate ornithological statistics of Ireland, such as the author intends to give in the detailed notices of the species throughout the work.—*(From an interesting work just published, viz., "The Natural History of Ireland." By Wm. Thompson, Esq., President of the Natural History Society of Belfast, &c., &c.)*

William Oakes, the American Botanist.

William Oakes, A.M., well known as the most distinguished botanist of New England, fell overboard from the ferry-boat between Boston and East Boston, and was drowned, on the 31st July 1848, at the age of forty-nine years. The services which Mr Oakes has rendered to that department of natural science to which he was so enthusiastically devoted, his active kindness of heart and liberal spirit, which endeared him to a wide circle of friends and correspondents,—no less than the painful circumstances of his death, in respect to which a misapprehension has obtained currency, which it is the duty of friendship to correct—all conspire to claim a tribute to his memory in the pages of the American Journal of Science. The writer regrets that the materials at hand for a biographical notice of his lamented friend are so scanty. There are, no doubt, many interesting reminiscences which might be furnished by the surviving companions of his earlier years. But the life of the naturalist who, instead of gathering the novelties of far distant regions, consecrates himself to the assiduous and complete investigation of the flora and fauna of his native district, is seldom eventful. The story of the life of William Oakes may be told in a few words. He was born at Danvers, Massachusetts, on the 1st July 1779. He received his earlier education in the common schools of his native town, with the exception of a few months passed, while preparing for college, under the tuition of the late Benjamin D. Oliver, Esq., then a practising lawyer at Danvers. He entered Harvard College in the year 1816, and was graduated, with credit, in 1820. His fondness for Natural History, which he brought with him to college, was developed under the instructions of the late Professor Peck, and his vacations, and probably no small

portion of his time while in college, were given to those studies which were to form the favourite occupation of his life. After his graduation, he spent two years at Cambridge as a law-student. The next year he studied in the office of the late Hon. L. Saltonstall, at Salem. On the completion of his professional studies, in January 1824, he removed to Ipswich (where he resided until his decease), and commenced the practice of law. This, however, he entirely abandoned in the course of two or three years, and devoted himself, with characteristic ardour, to the more congenial pursuit of Natural History in all its branches, and especially of botany, which was from the first his favourite department, and in which he was already a distinguished proficient.

Mr Oakes, although interested in every department of the science, early restricted himself to New England as the particular field of his labours, and seldom, if ever, herborised beyond its limits. There is scarcely a New England plant that he has not collected with his own hands, and prepared an abundance of surpassingly excellent specimens, and also subjected to a critical examination in a fresh state, the results of which were carefully recorded for future use. As early as the year 1830, he had already explored the alpine region of the White Mountains of New Hampshire, in conjunction with his friend Dr Pickering; and had projected a Flora of New England, to be arranged according to the natural system, with a Linnæan artificial key to the genera. The appearance of Dr Beck's Botany of the Northern States in 1833, upon a similar plan, caused him to abandon his own undertaking for a time; but he afterwards resumed the scheme with increased ardour, and upon a more elaborate scale. All his explorations, and his special undertaking converged upon this, as the principal work of his life. Towards this he had unweariedly amassed an immense store of materials, and if his premature death has left them in a state which shews little progress made towards their final elaboration, this is to be attributed not to any lack of industry or perseverance, but to a too fastidious taste, and an over-anxious desire not merely to satisfy the ever-increasing demands of the science, but to realize his own high standard of perfection. Indeed, such were the characteristics of his high mind in this respect, that he was never satisfied with any thing done as well as it reasonably could be at the time; and, in consequence, every piece of work that he undertook grew rapidly under his hands, until it became well nigh impracticable. This infirmity, if such it may be deemed, is one which every naturalist, who feels bound to do justice to his themes, can sympathize. It is but too well illustrated in Mr Oakes' case, by the particular undertaking which occupied his latest years, and from the midst of which he was suddenly removed. In the autumn of 1842, he was solicited to prepare a brief sketch of the botany of the White Mountains, with a catalogue of their alpine plants, to be appended to the final report of the Geological Survey of the State of New

Hampshire. Although he had repeatedly explored the mountains, and made their botany a special study in view of his projected New England Flora, he insisted upon visiting once more those favourite haunts, before committing his remarks upon their botany to writing. The consequence was, that new problems were presented much faster than they could be solved. The subject expanded in magnitude as it rose in interest. One exploration led to another, and a large part of every succeeding summer until the last, was untiringly devoted to these favourite investigations, and to the collection and preparation of literally *hundreds* of specimens, such as he alone could make, of nearly every species that inhabits these mountains, from the forest trees which cover their sombre slopes, to the low alpine flower and mosses that cushion their woodless summits, and the hoar-rock lichens that speckle their topmost crags. The space of a substantial volume was now requisite to do justice to the enticing subject; and the plan was enlarged accordingly. The geology, mineralogy, and zoology of the mountains claimed their share of attention: an excellent artist was employed in making drawings of characteristic plants; and, finally, of phytostatic views and illustrations of the scenery, of rare faithfulness and accuracy. As it became desirable to complete and publish these illustrations separately, in advance of the general work, to which they were at first intended as an appendix, but which they now threaten to overwhelm, Mr Oakes devoted his attention, and all his available resources to having them properly lithographed and published. After surmounting difficulties, one after another, which would have driven any less resolved man to utter despair, after cancelling plate after plate, which did not fulfil his expectations, Mr Oakes had just succeeded in completing them, had sent the last sheet of the text to the printer; and, moreover, had just been perfectly relieved from a temporary pecuniary embarrassment, in which it had involved him, when, in a mysterious Providence, he was suddenly removed from the scene of his labours, at the very moment they were crowned with success.

To detail the circumstances of the casualty by which a family-circle was bereaved of a fond husband and father, while society lost an estimable member, science an ardent votary, and many a naturalist a warm and trusty friend, would not, under ordinary circumstances, be either fitting or needful. But in this case, justice requires that his memory should be retrieved from the mistaken judgment of a hasty inquest, by a simple statement of the particulars of the melancholy occurrence, as they have been carefully collected by a friend of the deceased, and communicated to the writer of this notice. It appears, in brief, that Mr Oakes had been unwell during the previous week; that he was occasionally subject to sudden attacks of vertigo; that he was indisposed, and took no breakfast on the morning of the 31st, but left for Boston in an early train of cars, to arrange some business there, and return if possible by the eleven o'clock train;

that he was much exhausted by walking and by the heat of the day, that he stopped only a few minutes before the starting of the ferry-boat, at a store near the head of the wharf leading to the dépôt, to purchase some shot for gunning; that although he had but a few moments to spare, he took particular pains and trouble to select the two sizes of shot which he was accustomed to use, taking six pounds of one sort and four of another; that the bell ringing while he was making his purchase, he hurried with it to the dépôt; that he there met the gentleman whom he came to Boston to see, and received from him the answer he had been led to expect in regard to a business-transaction between them, and which precluded all pecuniary anxiety; that he hastily tied up his two packages of shot in his pocket-handkerchief, hung it upon his arm, for convenient carriage, and stepped on board of the boat just as it was leaving; that soon after the boat was out of the dock, he was observed standing or sitting at the stern, which was unprotected by a barrier, and the next moment he was seen in the water, where he sank before any effectual means could be used for his rescue. Under these circumstances there is every reason for believing that, in his exhausted state, he was seized with sudden faintness or vertigo, and fell overboard from the stern of the boat: an accident which was more likely to occur, from the fact, that he was very heavy, and awkward in his movements.

It is manifest from what has already been remarked, that Mr Oakes' services to American botany, are not to be measured by the amount of his actual publications. These consist principally, of a *Catalogue of the Plants of Vermont*, contributed to the "History of Vermont, Natural, Civil, and Statistical," by Zadock Thomson; and of two or three articles contributed to Hovey's Horticultural Magazine, comprising descriptions of new plants of New England, or notices of new localities detected by himself, or his friend Dr Robbins. These are but small indications of what he might have accomplished. But there are few botanists in this country who are not indebted to him, directly or indirectly, for some portion of their knowledge, or for some of the finest specimens in their herbaria; and there is no treatise, and scarcely an article on the botany of the Northern States, published within the last twenty years, to which he has not in some way essentially contributed. The immense collections of most beautiful specimens which he made with peculiar skill, were never hoarded, but were freely bestowed upon every botanist, upon every amateur indeed, who desired or who could appreciate them. When they accumulated in large quantities upon his hands, it was only because he was not yet prepared to distribute them in the form which seemed most fitting, nor yet able to enhance their value as he wished, by perfectly authenticating their names. More than once has he placed interesting collections in the hands of the writer, for foreign distribution, perchance among strangers who had never heard his name, accepting no return, other than the satisfaction of knowing

that they would be useful. When a botanist who then knew him only by a casual correspondence, lost his whole herbarium by fire, Mr Oakes prompt letter of sympathy was accompanied by the substantial encouragement of a fine package of plants, with which to commence the restoration, as well as with most cordial proffers of further assistance.

Mr Tuckerman has consecrated to the name of Oakes, already inseparably connected with New England botany, a beautiful and highly interesting evergreen, newly detected in several localities along our eastern coast (*Oakesia conrado*, Tuckerm., which is finely figured in the volume of the Memoirs of the American Academy, now just published); but even if that genus be superseded, his name will not perish from among us, nor the memory of his many virtues; of his active liberality, his manly and disinterested zeal, his untiring devotion to science, and his pure love to the objects of his study, for their own sake.—*American Journal of Science and Arts*. Second Series, vol. vii., p. 138.

On the Geological Structure of the Alps, Carpathians, and Apennines, more especially on the Transition from Secondary to Tertiary Types, and the existence of vast Eocene Deposits in Southern Europe. By Sir RODERICK IMPEY MURCHISON, F.R.S., V.P.G.S., &c.; Mem. Imp. Ac. Sciences of St Petersburg, Corresp. Member of the Academies of Paris, Berlin, Turin, &c.* Communicated by the Author, with Corrections and Additions.

This memoir, chiefly the result of the author's last excursion on the Continent, consists of three parts:—the first of which is an endeavour to bring up to the present standard of knowledge the work on the Eastern Alps, published long ago by Professor Sedgwick and himself,† and to extend the survey from that portion of the chain to Switzerland and Savoy. The second part is a brief explanation of his present views respecting the northern flank of the Carpathian mountains, and the third relates to Italy and the Apennines.

The Alps.—The central masses of the Eastern Alps, though

* Abstract of a Memoir read before the Geological Society, Dec. 31, 1848, and Jan. 17, 1849.

† *Trans. Geol. Soc. Lond.*, N. Ser., vol. iii., p. 301; and *Phil. Mag.*, N. Ser., vol. viii., Aug. 1830.

in parts highly crystalline, contain recognizable remnants of Upper Silurian, Devonian, and carboniferous deposits, as proved by organic remains; but no traces of the Permian system* of the author, so abundant in Russia, Germany, and England, have been found in them or in any part of Southern Europe. In the same regions, viz., in the South Tyrol and the Salzburg Alps, the above-mentioned palæozoic formations are succeeded by trias, with true "muschelkalk" fossils, as recently expounded by Von Buch, Emmerich, Von Hauer, and other geologists. But in following the central parts of the chain from Austria into Switzerland and Savoy, all fossil evidences of these palæozoic and triassic deposits cease; which, if ever they existed, have been obliterated by the very powerful action of metamorphism which has affected the Western Alps. The presence, however, of undoubted species of old coal plants in Savoy has led some geologists to believe that the carboniferous system had some representative there; whilst M. E. de Beaumont and M. Sismonda contend, that the association of such plants with belemnites proves that they occur in the lias of this part of the chain (Mont Blanc, Tarentaise, and Maurienne), so clearly recognized by its numerous animal organic remains. Sir R. Murchison allows, after personal inspection, that in the much-disputed locality of Petit Cœur, the coal-plants and anthracite really *appear* to lie in the same formation with the belemnites as described by M. E. de Beaumont.

After a notice of the better acquaintance of geologists at this day with the fossils of the secondary rocks of the Alps than when Professor Sedgwick and himself described them,—and after shewing the great value of the Oxfordian group of Von Buch as the clear uppermost zone of the Jurassic lime-

* The term "Permian," derived from the vast region of Russia, where this uppermost Palæozoic system is more largely developed than in any part of the world hitherto examined (see Russia in Europe and Ural Mountains), embraces in its meaning the Rothe Todt-liegende, Kupfer-schiefer and Zechstein of the German geologists, and among the latter, Professor Naumann, Dr Geinitz, and Capt. Gutbier, have recently adopted the new term. In England the term includes the Lower Red sandstone, and the magnesian limestone. As far as researches have gone, it would appear that the Permian system is omitted in Southern Europe.

stones,—the author goes to his chief point, and proves by a number of natural sections, that the opinion for which his colleague and himself formerly contended, and which met with so much opposition, is at length completely established,—that the flanks of the Alps exhibit a *true transition from the younger secondary into the older tertiary strata*. But whilst this principle was correct, the author allows that his friend and himself were in error in applying it to the Gosau deposits; all the lower and fossiliferous parts of which he now admits to be cretaceous. In common with all the geologists of their day, they also formed an erroneous opinion of the age of the “flysch,” in viewing it as secondary greensand.

He now specially refers, as the base of all his subsequent results, to a memoir of his own, read before the Geological Society in 1829 (*Annals of Phil.* and *Phil. Mag.*, June 1830), which proved, that on the edge of the Venetian Alps, near Bassano and Asolo, the white and red scaglia, or chalk, is there conformably succeeded by the nummulitic and shelly deposits of the Vicentine, which are unquestionably of lower tertiary age, and graduate upwards through other shelly strata and sandstones into marls and conglomerates with sub-Apennine fossils. It has since been ascertained that deposits with the same shells, Echinidæ and nummulites of older tertiary age enter far into the higher Alps of the South Tyrol, and are there elevated to great heights on the surface of limestones which represent the chalk. Natural sections are then described in Savoy, Switzerland, and Bavaria, which shew a clear ascending order from the Neocomian limestone (a formation unknown when he formerly visited the Alps), or equivalent of the lowest greensand of England, through a zone charged with fossils characteristic of the gault and upper greensand* into a limestone containing *Inocerami* and *Ananchytes ovata*, which, whether of white, grey, or red colour, unquestionably stands in the exact place of the white chalk of Northern Europe. Certain conformable *transitions* from this inoceramous limestone up into shelly and nummulitic

* See the excellent work of Professor Pictet of Geneva on the fossils of this band of upper greensand and gault.

strata, like those of the Vicentine, are pointed out, particularly at Thones in Savoy, at the Hoher-Sentis in Appenzell and near Sonthofen in Bavaria, where these intermediate beds, partaking of all the mineral characters of the great supercretaceous groups, or "flysch," are still characterized by a Gryphæa, which is not to be distinguished from the *G. Vesicularis* of the upper chalk. Above this zone (*i. e.* in tracts free from dislocation and inversion), no traces have been discovered of any one fossil referable to the cretaceous system; the overlying strata being unequivocally nummulitic and shelly rocks, which are linked together by position and fossils, and which on the north flank of the Alps (especially at Sonthofen and Kressenberg) as well as on the high summits of the Diablerets and Dent du Midi, represent the lower tertiary of the Vicentine. The upper portion of this group, so vastly expanded on the north flank of the Alps, is a collection of shale, impure limestone, and sandstone, the "flysch" of the Swiss, to a great extent, the "Weiner Sandstein, or fucoid grit" of the Austrians,* and to a great extent, the "Macigno" of the Italians. The whole group of nummulite rocks and "flysch," much loaded with chlorite pre-eminently a "greensand," and often assuming a very ancient lithological aspect, is not, as many geologists (including himself) supposed, an upper member of the cretaceous rocks, but really represents the true eocene. The adoption of this view, which it is supposed all palæontologists must adhere to, seems already to be also in great part taken by M. Boué, in opposition to his former opinion. In reviewing the physical relations of the upper secondary and lower tertiary rocks of the Alps, it is made manifest that the *independence* of any one member of this succession cannot be assumed from its *unconformability* to others in certain localities, inasmuch as such appearances are proved to be local phenomena only, by a more general survey which detects the order to be unbroken and continuous. In the Alps, therefore, as in Russia, where deposits of several ages are conformable,

* In an able map of the Northern Alps of Bavaria and Austria, M. Morlot had placed the nummulite and flysch rocks above the chalk. Now, however, great confusion prevails among the Austrian geologists respecting the position of the "Weiner Sandstein," which has recently been mapped as "Keuper."

the *limits of formations* can alone be defined by their imbedded organic remains.

The author next developed the true age of the "Molasse and Nagelflue" of the northern portion of the Alps. Citing the researches of Professor Studer, M. Escher, and others, he shewed that the axis or older part of these tertiary deposits was usually removed to some distance from the higher ridges of cretaceous and eocene rocks, and consisted of fresh-water strata; that the central or marine accumulations are, from their fossils (as collected in the Cantons St Gallen and Berne), of sup-Apennine or Pliocene age, and that the great overlying portion of molasse and nagelflue, which frequently (owing to enormous dislocations) seems to *dip under the older rocks, out of which it has been formed*, is again, as far as can be ascertained, of terrestrial and fresh-water origin. Following these deposits in ascending order, to their outermost and superior zone, they are found to be surmounted by the well-known lacustrine formation of *Æningen*, formerly described in some detail by the author.* The remarkable feature of this deposit is, that although it has unquestionably been formed long after pliocene marine deposits (in which shells exist undistinguishable from those now living), its Fauna and Flora consist entirely of lost species. The examinations of its quadrupeds, chelonia, and reptiles by Herman von Meyer and Owen, of its fishes by Agassiz, and of its plants by Göppert, all lead to this conclusion. Even in respect to the insects of *Æningen*, Professor Heer, of Zurich, has recently satisfied himself that in a multitude of species which he is about to describe not one is identifiable with a living form. Hence, Sir Roderick maintains, that the terms Miocene and Pliocene cannot be correlatively deduced from submarine and terrestrial formations; since, if this be done in Switzerland, types of lost terrestrial species overlies existing marine forms.

In concluding his observations on the Alps, attention was called to the extraordinary contortions and convulsions they had undergone. By diagrams of various transverse natural

* See Trans. Geol. Soc. Lond., vol. iii., New Series, p. 277.

sections, it was shewn that the Oxfordian, cretaceous, and eocene or nummulitic groups had conjointly undergone such great flexures as in many instances to produce absolute inversions, and in others great ruptures, both longitudinal and transverse. Whilst the direction of the sedimentary rocks is shewn to conform to the axes of certain great ellipsoids of crystalline rock, whether eruptive or purely metamorphic, the deviations from such conformity are very numerous, particularly where the strata wrap round the ends of each separate crystalline mass; in illustration of which a geological map of the Canton of Glarus, by M. Escher, was appealed to. Seeing that the forms of the anticlinal and synclinal folds exhibited in his sections coincided with the illustrations of the Appalachian mountains and other chains recently produced by Professor H. Rogers, the author—without offering any opinion on the theory of that able geologist—pointed out that in the Alps, as in the United States, the long and slightly-inclined slopes of each anticlinal face the great centre of disturbance, whilst the short and steep sides of the same dip away from the chain. In reference to the very frequent phenomenon of the younger strata) including the molasse) dipping under the older, particularly along the line of great longitudinal faults, Professor Rogers presented diagrams explanatory of such overlaps in accordance with his theory.

Carpathians.—A brief sketch, the result of a survey in 1843, is then given of the northern flanks of the Carpathian mountains. Indicating the general succession northwards from the Tatra chain, the author points out how a mass of nummulitic limestone, overlying secondary rocks, dips under shale and sandstone like the flysch of the Alps, such deposits representing, as in those mountains, the eocene of geologists. An outer ridge (Zafflary and Rugosnik) of Oxfordian Jura, and chiefly Lower Neocomian, according to Zeuschner and Keyserling, rises abruptly through these superior deposits; and between it and Cracow are undulating hills, much broken up and dislocated, consisting of sandstones, shale, &c., in parts of which Professor Zeuschner has discovered many secondary greensand or Neocomian fossils. These sandstones

have a wide range, extending into Moravia, and, doubtless, constitute a large portion of what has been termed Carpathian grit. But the author observes, that, in tracts like this, where the cretaceous system assumes an arenaceous and earthy form, and particularly in those districts where the nummulitic limestones no longer exist, it is exceedingly difficult to draw any clearly-defined line of separation between sandstones of secondary and tertiary age. He, therefore, believes that under the name of "*Gres des Carpathes*," rocks both of eocene and cretaceous age have hitherto been confounded; and that arguments concerning the age of any given portion of these sandstones in a country so constituted and so full of dislocations, are valueless without the test of organic remains.

The Apennines.—A general view of the structure of Italy is then offered; and, whilst, on the authority of General della Marmora, the existence of Silurian rocks in Sardinia is cited, it is shewn that the lowest fossiliferous deposits of the Peninsula are liasso-jurassic, followed by limestones, often of red colours, of Oxfordian age (*ammonitico-rosso*). These constitute a number of parallel ridges of various altitudes, overlaid by or forming troughs with younger accumulations, and thus constituting numerous backbones, of which the Apuan Alps and their crystalline marbles, the hills of La Spezia and Pisa, are the most prominent examples in the North.

Admirably exposed on the flanks of the Venetian Alps, and scarcely less so at Nice, the cretaceous system, in all its members (from the Neocomian limestones of foreign geologists or equivalents of the English lowest greensand, up to the white chalk inclusive), is surmounted by nummulitic eocene deposits, which, near Asolo and Bassano, are followed by miocene and pliocene shelly strata. After shewing how they occupy a trough between such Alps and the Eugeanæans, the author explains how the latter hills have recently been described by M. de Zigno as composed of Oxfordian Jura and a full cretaceous system up to the white chalk inclusive, overlaid by the nummulitic group. In Liguria, Modena, Lucca, and Tuscany, such clear evidences do not exist; for *there the formations above the Oxfordian Jura are singularly*

devoid of fossils; and the series between that horizon and the deposits of miocene age, with the exception of certain flaggy limestones (*Alberese*), assumes an arenaceous type. At very rare intervals only, and chiefly to the south of Florence, are any bands of nummulites observable; but where they occur, the author refers all the "macigno" sandstone which is associated with them, to the eocene epoch; such rocks being perfectly undistinguishable from the "macigno Alpin," or *flysch* of the Alps. As, however, these rocks repose upon others, including vast thicknesses of the *Alberese* limestone, so largely seen in the Apennines between Bologna and Florence, and in the northern part of the Tuscan Maremma, it is presumed that much of the latter *may* represent the chalk. For, although these rocks contain *fucoids*, one or more of them being said to be similar in species to those which overlie the nummulite strata of the Alps, no sort of reliance can be placed on the presence of such marine vegetables, which, in the Alps, range from the lower chalk high into the eocene. On the other hand, in Tuscany, an ammonite and a hamite have actually been found in these infra-nummulitic masses; and hence the inference of the author is, that Professor Savi, though correct in viewing a portion of this series as cretaceous, has erred in including in it the nummulitic rocks.

In paying a just tribute to the talents, labours, and character of the lamented Professor Pilla, the author avows the impossibility of admitting his term of "*Systema Etruriano*" as an equivalent for any true geological division, as in it are comprehended strata which that writer had admitted to be cretaceous, with others which it is the chief object of this memoir to establish as lower tertiary.

In passing into the Papal States and Naples, the superposition of the nummulitic limestones, with their usually associated fossils, to hippuritic limestones, the equivalents of the chalk, is seen to be resumed; and thus the same general succession as in the Alps and Carpathians is maintained. Cases illustrative of this order, with much overlying macigno, are pointed out in the Sabine Hills and in the kingdom of Naples.

A transverse section of the Monferrato Hills (Superga) near Turin, exposes a most instructive tertiary succession. A coralline concretionary limestone, with small nummulites (Gassino), though described and mapped as cretaceous by Collegno and others, is shewn to lie at the top of the eocene or bottom of the miocene, and to pass up through conglomerates, marls, and sandstones, replete with the well-known miocene types of the Superga, into the blue marls and yellow sands of the Astesan, which are of sub-Apennine age. The great interest of this section lies in its exposure of a vast thickness of intermediate beds, in which the per-centage of recent and fossil species is of so mixed a character, that for a league across the inclined strata, the able palæontologists, E. Sismonda and Bellardi, who made the section with the author, found it impossible to draw a defined line between miocene and pliocene accumulation, so completely do they inosculate.

After describing the relations of the miocene and pliocene formations near Bologna and in the Tuscan Maremma, including the great coal-beds in the latter, which are believed to be of the older miocene date, the relations of all these marine tertiary deposits to younger terrestrial and fresh-water travertines and limestone is traced; and reference is made to the more recent changes in the configuration of the Campagna di Roma and valley of the Tiber, with allusions to the labours of Monsignore Medici Spada and Professor Ponzi, from whom he announced future communications; the one on the igneous rocks of Latium, the other on the sedimentary deposits of the Papal States.

After briefly recapitulating the principal phenomena in the Alps, Apennines, and Carpathians, the author dwells, in conclusion, on the chief aim of his present communication, viz., the establishment of a true equivalent of the eocene in Southern Europe. He analyzes the writings of the geologists who have recently described the nummulitic formations in the south of France, viz., Leymerie, Pratt, D'Archiac, Delbôs, Raullin, Tallavignes, Rouant, &c.; and indicates how their facts and his own are in harmony, in shewing the superposition of such deposits to the true cretaceous system, no characteristic fossil

of which has been continued into the nummulitic group. Two or three species of *Grypheæ* are alone common to the upper beds of the one and the lower beds of the other. All the other fossils associated with the nummulites, whether from the Vicentine on the south, or from Sonthofen and Kressenberg on the north of the Alps, are of tertiary forms, a certain number of them being absolutely identical with species of the London and Paris basins. Looking to the very great thicknesses and fine lamination of these accumulations, including the shale, sandstone, and limestone above the nummulites in the Alps, it is contended that, as all these surmount the white chalk, they must be an equivalent *in time* of what is legitimately eocene; and that they do not merely represent, as suggested by that eminent geologist M. E. de Beaumont, the interval which, in the North of Europe, has occurred between the termination of the chalk and the commencement of the plastic clay.

Extending the application of his view to still more southern and eastern regions, Sir Roderick Murchison is of opinion, that the great masses of the nummulitic limestone of the Crimea, Africa, Egypt, and Hindostan, are also of eocene age; or, in other words, that, from the Carpathians to Cutch, at the mouth of the Indus, a space of not less than 25° lat., has been occupied by sea-basins, in which creatures of this era lived. In reference to Egypt, he cites copious collections of shells and nummulites, chiefly those at the Royal Museum of Turin, examined by M. Bellardi and himself; and in regard to Hindostan (after reverting to the Cutch fossils collected by Grant and described by Sowerby), he pointedly dwelt on the rich and instructive supplies of them recently sent home to him by Captain. Vicary from Scinde and Sabathoo, and examined by Mr Morris, which not only demonstrate the existence of this same group in the Hala range, extending northwards towards Cabul, but also along the southern edge of the Himalaya Mountains.

The inference, then, is, that it is necessary to separate the vast nummulitic formation, which the author believes to be eocene, from the cretaceous system, with which it has *hitherto been merged*; and hence, that a great change must

be made in geological maps, and in the classification of the rocks of this age, in South Europe and other parts of the world. The union of the nummulitic and cretaceous groups in one system, has been almost exclusively based upon the prevailing phenomenon of both having undergone the same movements, and having been often elevated into the same peaks and ridges. But such agreement in physical outline cannot be admitted as invalidating the clear testimony borne by organic remains, and from the study of which Brongniart, Deshayes, Agassiz, D'Orbigny, and Bronn, have all placed the nummulitic group as lower tertiary. Patient geological researches, therefore, at length prove, that, when clear from obscurities and unbroken, the order of superposition is in harmony with the distribution of animal remains.

[*P.S.*—In the course of the memoir, of which it is difficult to explain even the chief points in an abstract, the author particularly cites Professors Studer and Brunner, jun., and M. Arnold Escher von der Linth, as having rendered him very great services in his examination of the Swiss Alps. In reference to Savoy, he mentions the Canon Chamousset and M. Pillet; and respecting the Eastern Alps, he points out the assistance he received, first from the co-operation of his old associate M. de Verneuil in his re-examination of Styria, Go-sau, &c., and afterwards from M. Leopold de Buch, to travel with whom through any part of that chain is to ensure good results. It was when with M. de Buch and M. de Verneuil that he explored the Triassic deposits of the South Tyrol. In attending the Venetian Meeting of the Italian "*Scienziati*," in the autumn of 1847, the author further necessarily acquired much additional knowledge there from intercourse with the geologists who have worked out the details of that region, including Pasini, Catullo, and De Zigno, and he was then led to institute comparisons between some of the results of the Marquis Pareto on the western slopes of the Southern Alps, and with those of the Austrian geologists, V. Hauer, Morlot, &c., in the east, as well as from that excellent palæontologist, M. Ewald, of Berlin. But as, at that time, Sir Roderick had

not examined either the Swiss and Savoy Alps, the Monferato, Apennines, or Southern Italy, any words he may be cited as having spoken at that meeting are not to be taken as affecting his ultimate conclusions expressed in this memoir. Since it was read, he has received a letter from M. Alcide d'Orbigny, which he willingly cites both as confirming his general conclusions and as bringing these deposits into close comparison with the lower tertiaries of Northern Europe. "For three years," M. d'Orbigny writes, "I have made the most extensive general researches on the strata containing nummulites; and, in comparing all the stratigraphical and palæontological results, it is impossible not to recognise therein two distinct epochs superposed the one to the other, and having each its proper fauna. One of these epochs, which I have recognised in the French Alps, the Pyrenees, and the Gironde, corresponds to the plastic clay of Paris and London, and which, belonging to the lower sands of Soissons, I have named 'Etage Suessonien;' the other, equally common in the Alps and the basins of the Gironde, and which includes the 'Calcaire Grossier' of Paris, up to the gypsum of Montmartre and the London clay, &c., I designate 'Etage Parisien.' These divisions, based upon a considerable number of facts, are detailed in the work I am now printing, and the entire composition of their characteristic faunas is given in my 'Prodromus of Universal Palæontology.' The habit I have acquired of determining these fossils, makes me regret that I cannot go to inspect your collections in London; but the portions of them I have seen, in the hands of our friend M. de Verneuil, has led me to recognise, at once, what I was already acquainted with in the Pyrenees and the French Alps. Again, the fossils I have examined in the collection of M. Tchichatcheff, confirm me in my opinion, and would lead me to extend the limits of these tertiary stages, as you have suggested, through Asia Minor, and other tracts, even to Hindostan."

It may be added, that, in citing the able memoir of M. Coquand,* Sir Roderick has expressed his opinion, that the data,

* *Déscription géologique de la partie septentrionale de l'empire de Maroc*, par H. Coquand.—*Bull. de la Soc. Géol. de France*, Second Series, vol. iv., p. 1188.

though construed differently by that author, may be so interpreted as to lead to the conclusion that the mass of the rocks containing nummulites, in the Barbary states and the shores of the Mediterranean, are, like those of the Alps and Apennines, supra-cretaceous; his own limited observations in the Neapolitan territories being confirmed by the local knowledge of Professor Scacchi. Similar conclusions are, he thinks, inevitable respecting the nummulitic rocks of Egypt, on the part of any one who has read Russegger's work on that country. At the same time, though well-assured of his own facts, he would not argue against the possible existence in certain southern regions, not examined by him, of some one species of nummulite in strata of the age of the uppermost chalk, as insisted upon for the Crimæa by M. Dubois de Montpereux, and for Cape Passaro in Sicily by M. Constant Prevost. All that he contended for is that the *great* nummulitic group, as characterised by a multitude of species of shells, Echinoderms, nummulites, &c., is a formation superior to and distinct from the chalk; and if there be situations (which, however, he has never seen) in which a species of nummulite be common to the uppermost chalk and lowermost tertiary, they would only the more confirm his view of *transition from the one epoch to the other* in some regions of the surface of the globe, as proved by other fossils, and the nature of the strata. In the memoir about to be published, the author will give the result of the comparison of the species of the nummulites, whether collected in the Alps or Hindostan, with those of the south of France by M. le Vicomte d'Archiac, who has obligingly compared them. In the mean time it may be stated, that, however, the species may have been differently named by authors; that able palæontologist has assured himself that the *very same forms* of nummulites, orbitolites, and Echinoderms, exist in the south of France, the Pyrenees, the Alps, the Crimæa, Egypt, and India.*

* It was my wish to have communicated to my valued friend, the editor of this Journal, Professor Jameson, a sketch, however brief, of some of the chief results at which I had arrived concerning the glaciers, moraines, and erratic blocks of the Alps; the more so as his Journal was the chief medium for the

On the Action of Chloroform on the Sensitive Plant (Mimosa pudica). By Professor MARCET of Geneva.*

When one or two drops of pure chloroform are placed on the top of the common petiole of a leaf of the sensitive plant, this petiole is seen almost immediately to droop, and an instant after the folioles close successively pair by pair, beginning with those which are situated at the extremity of each branch.† At the end of one or two minutes, sometimes more, according as the plant is more or less sensitive, most of the leaves next to the chloroformed leaf, and situated beneath it on the same stalk, droop one after another, and their folioles contract, although generally in a less complete manner than those of the leaf placed in immediate contact with the chloroform. After a rather long time, varying according to the vigour of the plant, the leaves open again by degrees; but, on trying to irritate them by the touch, it is seen that they

publication of the important discoveries and observations of Professor James Forbes. But the subject of the geological structure of these mountains is so widely separated from that of glacial action, that I must crave a separate place for the latter. When the occasion arrives, I shall endeavour to limit and circumscribe the extension of a certain hypothetical monster glacier of former times, which, issuing from such narrow defiles as that of the Rhine, was supposed to have spread out over the whole of the Canton de Vaud, and to have advanced to the Jura; for although I believe that many of the Alpine glaciers were formerly much more extensive than at the present day, their true ancient boundaries can still be very well defined. I will farther try to prove that the chief phenomena of erratic blocks around the Alps are the same as in the tracts around Scandinavia and Lapland; where, I hope, it has been clearly demonstrated that the blocks have been floated on ice-rafts; and, lastly, it will be proved, *by recent facts*, that, where large masses of gravel or drift slide over the face of a rock, they produce exactly those striæ, grooves, and polish, which have been erroneously attributed to the action of glaciers only.

LONDON, 16 BELGRAVE SQUARE,
6th March 1849.

* Read before the Société de Physique et d'Histoire Naturelle, October 19, 1848, and communicated by Mr Marcet, junior.

† I previously convinced myself by experiment, that a drop of water placed delicately on a leaf of the sensitive plant, caused no movement.

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have become nearly insensible to this kind of excitement, and no longer close as before. They thus remain as if torpid for some time, and generally do not recover their primitive sensitiveness till after some hours. If, however, when they are in this state of apparent torpidity, they are subjected again to the action of the chloroform, they close as they did the first time. It is not till after they have been chloroformed several times, that they lose all kind of sensitiveness, at least until the next day; sometimes they even fade completely at the end of too frequent repetitions of the experiment. In all cases, the effects observed are the more marked in proportion to the purity of the chloroform employed, and the degree of sensitiveness in the plant.

An analogous phenomenon is produced, if, instead of placing the drop of chloroform on the base of the petiole, it is laid on the folioles situated at the extremity of a branch. The folioles of this branch immediately begin to close pair by pair, the common petiole droops, lastly, the folioles of the other branches close in turn at the end of two or three minutes, the nearest opposite leaf, and, if the plant be vigorous, most of the other leaves situate below on the same stalk, follow their example. When, after some time, the leaves open again, the same want of sensitiveness is manifested as in the preceding case.

A singular feature in this phenomenon is the manner in which the action of the chloroform is propagated from one branch to another, then from one leaf to another, even when the liquid disappears by evaporation almost as soon as it is deposited. This action, as we have just seen, appears to be communicated from the leaf to the stalk, following in the latter a descending direction; generally the leaves situated beneath the chloroformed leaf are not at all affected. De Candolle, in making an analogous experiment on a sensitive plant with a drop of nitric or sulphuric acid, remarked, on the contrary, that it was the leaves above the leaf touched which closed, without those situated beneath participating in this motion.* The observation of our learned countryman is quite

* De Candolle *Physiologie Végétale*, vol. ii., p. 866.

naturally explained by attributing to the ascending sap the transport of the corrosive poison, a transport which, in this case, would take place in the direction from below, upwards. But, how to account for the apparent transmission of the effects of the chloroform in the contrary direction, from above, downwards. Might the descending sap more peculiarly have the property of transmitting the narcotic effects of this singular compound from one part of the sensitive plant to the other; or might there exist in this plant some special organ susceptible of being affected by certain vegetable poisons in a manner analogous to the nervous system of animals? Notwithstanding the interesting investigations of Dutrochet and other physiologists, there still prevails too much obscurity on this subject to hazard an opinion. But, in any case, the fact is singular, and appears to me to merit the attention of persons accustomed to engage in questions of this nature.

Experiments of the same kind, made on the contractility of the sensitive plant with rectified æther, have furnished me with results nearly similar to the preceding; with this difference, however, that whilst one drop of chloroform placed on the common petiole of a leaf situated at the extremity of a branch of a sensitive plant, suffices to cause most of the other leaves situated beneath on the same branch to close, æther in general produces an effect only on the leaf itself with which it is put in contact. The next leaves have generally appeared to me not affected. I must, however, add, that my experiments with æther having been made after the others, and at a time of year when the sensitiveness of the plant began to diminish, it is possible that the intensity of the effects produced may have thereby been affected.

Addition by the Editor. — In Professor Simpson's interesting observations on Local Anæsthesia, we find the following notice, which we trust is but preliminary to a more extended series of experiments on this subject, by Professor Balfour: "Through the kindness of Professor Balfour I have had various opportunities of trying the effects of chloroform vapour upon the sensitive plant (*Mimosa pudica*). When the vapour was either too strong or too long continued, the plant was destroyed. When it was weaker and

applied only for a few minutes, the leaflets in some plants closed as when irritated, and did not expand again for an unusual length of time. In other plants under exposure to the chloroform vapour, no closure of the leaflets took place, and, in a few minutes, the plant became so anæsthetized, that the mechanical or other irritation of the leaflets or stalk did not produce any of the common movements, nor did their irritability become restored for a considerable time afterwards."

On a Passage, in a Recent History of the Royal Society, relative to the late Sir Humphry Davy. In a Letter Addressed to Professor JAMESON, by JOHN DAVY, M.D., F.R.S.

MY DEAR SIR,—In a recently published History of the Royal Society by Charles R. Weld, Esq., assistant-secretary to the Society, in a note to that part of the work in which some account is given of Sir Humphry Davy, is the following passage, which I am induced to notice, believing equally that the statement in it is founded on some mistake, and that Sir Humphry Davy was incapable of the act implied in it. The passage is the following:—"It may not be generally known that Sir Humphry Davy unsuccessfully petitioned Government for the red ribbon of his predecessor in the Chair of the Royal Society. He felt so certain his request would be granted, that his name was printed with the coveted letters K.B. appended. Captain Smith, to whom I am indebted for this anecdote, assures me that he saw these letters attached to Davy's name in a printed and published document."

In this statement two things are asserted; one, that Sir Humphry Davy petitioned Government for the red ribbon of his predecessor, in the Chair of the Royal Society; the other, that, confident of obtaining it, the letters K.B. were appended prospectively to his name.

As regards the first, there surely is a mistake. Sir Humphry Davy, I know, was peculiarly averse to ask any favour

of Government, and never did for himself. It is understood, however, that a nobleman, whose name I could mention, made for him an application for the distinction in question. This, and its failure, which may have been spoken of at the time, might have given rise to the report that he himself had petitioned for it.

As regards the second ; if the letters K.B. were ever appended to his name, I feel equally confident that it must have been by mistake. How highly improbable it is that any man in London society would expose himself to the ridicule of using an honorary distinction before it had been formally conferred on him !

As a kind of confirmation that the letters were attached to his name, I have had pointed out to me that, in a paper published in the Philosophical Transactions for 1823, Sir Humphry Davy is styled the Right Honourable.

The heading of the paper is the following—

“On Fossil Shells by L. W. Dillwyn, Esq., F.R.S. In a Letter addressed to the Right Honourable Sir Humphry Davy, Bart., President.”

Now, keeping in mind that the President of the Royal Society is no wise concerned in the editing of the Philosophical Transactions, a duty performed by the junior secretary, does not the mistake of title in this instance tend to show that the letters K.B. might have been attached to his name on some other occasion without his knowledge ? It may be worthy of remark that, in the same volume of the Transactions, whether in the heading of his own papers, or of other papers communicated by him (excepting Mr Dillwyn's) the titles of Bart., and President of the Royal Society, merely, were affixed to his name, and so always after, although then foreign member of the French Institute, and honorary member of most of the scientific societies of Europe.

For the sake of my Brother's memory, will you do me the kindness to insert this letter in the Philosophical Journal. I remain, my dear Sir, very faithfully yours,

J. DAVY.

TO PROFESSOR JAMESON.

On the Relations of Trap-Rocks with the Ores of Copper and Iron, and the Similarity of the Schalstein of Dillenburg, the Blatterstein of the Harz, and the Gabbro of Tuscany.

I. The Relations of Trap-Rocks with Ores of Copper and Iron.

Under the denomination of trap-rocks, we comprehend the silicates with isomorphous bases of magnesia, lime, and protoxide of iron; rocks of sombre colours, green and blackish, generally but slightly crystalline, known by the names of greenstone, mandelstein, amphibolite, diorite, amygdaloid, spilite, variolite, euphotide, and serpentine,* forming eruptive groups distinctly characterised.

With regard to composition, these rocks, although less silicated than the quartzo-felspathic rocks which have preceded and followed them, present us with alumina only in small proportion, either as an accidental substance, or in the euphotides, variolites, diorites, or labrador melaphyres, which are found in them in subordinate masses towards the line of contact with the eruptive groups. The trap composition is shewn by the deep colours, green and black, which contrast with all the other rocks that surround them; the superficial alterations indicate the presence of iron by the ochreous tints, and, when the iron is in small proportion, as in serpentine, the power of resisting decomposition, and the persistence of the mineralogical characters, still further become a special characteristic, when all the adjoining rocks exhibit the effects of decomposition.

The trap-rocks are distinguished by their homogeneous characters; we may traverse for two entire hours the serpentine surfaces of Italy and the greenstones of Germany, without finding any substances crystallised, and of well defined composition. Diallage, steatite, amphibole, pyroxene, and yenite are the only crystalline minerals whose presence is

* We do not mean to comprehend, in the series of trap-rocks, all those which bear these denominations; the diorites, for example, belong to the felspathic group; but, in certain countries, particularly in the Harz, these names have been applied to rocks evidently of the trap series.

normal, all the others are rare, and occur towards the line of contact. Thus the spilites and amygdaloids, with nodules of zeolite or calcareous spar, are only found at the edges of the trap accumulations, when they often form small hills, or particular *pitons*, in the same manner as the euphotides and the melaphyres. When we compare them with the porphyritic rocks, we cannot fail to be struck with the absence of quartz; the fibrous quartz of Italy is very rare; the agates and resinous quartz of Oberstein, &c., belong to rocks of contact. The rarity of felspar, which, along with quartz, had hitherto been the dominating principle in the eruptive rocks, is a fact not less interesting; and it worthy of remark that the *jades* and labradores, which are the only accidental felspars in the trappean groups, are the least silicated of this mineral family.

Certain rare substances, such as apophyllite, datholite, prehnite, &c., are found in some trap groups, very distant from each other, with a remarkable similarity in the circumstances of their position. These minerals, for example, are found in small contemporaneous veins, and in crystalline *geodes*,—

1st, In the traps of Kewena-Point and the southern shores of Lake Superior, in North America.

2d, In the traps of Hindostan, at Pounah, &c., in Asia.

3d, In the greenstone of the Harz, at Andreasberg, &c., in Europe.

On studying collections, we cannot fail to be struck with the identity presented by trap specimens from the most remote provinces. If, however, we examine the relations of the trappean rocks with the ores of copper and iron, we will find identities much more remarkable and important, in the nature of the ores, and in the circumstances of their position (*gisement*).

The metalliferous repositories, with the exception of the vein-fissures, are almost always in relation with the eruptive rocks, a relation of contact, vicinity, and parallelism, and in certain cases of mutual penetration; so that ores really exist whose origin is eruptive. The facts relating to these

relations of ores are so numerous that a true law of position (*gisement*) results from them; and if we point out the metalliferous repositories in a country, nothing is more rational than the questions: What are the eruptive rocks to which the ores are subordinate? What are the particularities of their relations?

In a former work (*Etudes sur les Mines*, 1844), we have explained the eminently metalliferous characters of the serpentine formations of Tuscany, referring the numerous cupriferous and ferriferous repositories of the country to these rocks. In the present case, we propose to prove, that these relations are not exceptional; that many trappean rocks present analogies with those of Tuscany, in the nature of the rocks of contact, and in the ores of copper and iron which are connected with them. Let us, in the first place, state, in a few words, the general conditions of the serpentine formations of Tuscany, and of the subordinate minerals.

From Savona, in the Gulf of Genoa, to beyond Monte Argentario, the serpentines form the principal features of accretion in the littoral chain which thus traverses the territories of Genoa, Modena, Lucca, and Tuscany; throughout the greatest part of its course this is called a metalliferous chain. The characters of the serpentines are eminently eruptive in the composition and in the forms of the masses, and particularly in the circumstances of upraising and alteration, which they have produced in the rocks traversed. The rocks of contact, designated by the general name of *gabbro*, may be divided into two classes, the *green* and the *red gabbro*.

The red gabbro are in some measure the first rocks of contact which have been remarked and signalised as metamorphic. Their red colour, which is owing to a considerable quantity of earthy oligistic iron, forms a contrast with the ordinary colours of the sedimentary formations of the country, and with the serpentines themselves. There is no trace of stratification in the true gabbro-rosso; its structure is often brecciform, and green steatitic fragments may be distinguished among the red fragments which predominate; often also, pyroxene and calcareous spar are met with in it.

The characters of the gabbro, analogous to those of the spilites, leave the mind in doubt as to their origin. When we observe them constituting insulated *pitons*, with forms similar to those of the serpentine *pitons*, we are tempted to suppose them eruptive; but, on the other hand, they are connected with slaty rocks evidently stratified (*galestri* and *mattoni*); and we cannot fail, moreover, to be struck with the fact, that *the condition of their existence* is the contact of the serpentine masses to which they are always subordinate. On examining from a distance certain upraised masses, whose sides have been laid bare, and keeping in view the movement of the rocky masses, and their structure on a large scale, the eye seizes, with considerable precision, what form the lines of separation between elevating rocks and such as have been elevated. Then, on approaching nearer, we perceive that the lines of contact thus presented, always leave the gabbro with the stratified rocks.

The study of the green gabbro confirms this classification of the gabbro-rosso among the rocks of contact. The serpentine, indeed, presents physical characters contrasting so strongly with the gabbro-rosso, that we feel difficulty in admitting that the latter rock is derived from the former; the green gabbro proves the transition. This rock, in fact, is steatitic, like the serpentines to which it is sometimes united, as well as to the slaty rocks evidently stratified. At the same time, it likewise passes into the gabbro-rosso, by becoming streaked with the red sporadical parts, and then being generally charged with the peroxide of iron. It thus appears to us demonstrated, that the gabbro-rosso was nothing more than a green gabbro of contact, which had been subjected to particular influences, the result of which has been to charge the rock with oligistic iron, rendering it everywhere harder and more crystalline.

The ores of copper and iron which form the characteristic feature of the metalliferous chain, are either in some measure enclosed in the rocks of contact, or disseminated through the eruptive amphibolites which are themselves connected with the serpentines. Thus the steatitic veins which, for the most

part, separate the green and red gabbro from the serpentine masses, which at times pervades these gabbros parallel to the curves of contact, must be, it appears to us, the emanations which have immediately followed the serpentine eruptions. The cupriferous and plumbiferous amphibolites of Campiglia are the different results of analogous actions, insulated from the serpentines, but which are contemporary with them. Among mines of iron, the celebrated repository of Rio, in the Island of Elba, has appeared to us to be one of contact placed between the gabbros and the less altered rocks, but subordinate to the serpentine masses of St Catherine; while the eruptive repository of la Calamita, with its yénites and amphibolites, was, like those of Campiglia, a more direct produce of subterraneous action. Finally, we have mentioned that we consider the oligistic iron, which the gabbros and stratified formations have so often imbibed towards the points of contact with the serpentines, as resulting from the same metalliferous emanations.

Such are the facts which we have illustrated in detail in the *Etudes sur les Mines*; let us now endeavour to find analogous facts.

The cupriferous repositories of Santiago de Cuba are acquiring remarkable importance. In 1846, there were despatched from that port, for Wales, 40,000 tons of copper ore, that is to say, upwards of 6000 tons of copper. This enormous produce has completely eclipsed the exportations from Chili and Bolivia, whose ores now appear at Swansea only in secondary proportions. The repositories thus developed, well deserve the attention of geologists, and we are indebted to M. Arrieta for interesting information on the principal mines, and the rocks which contain them. It appears from his communication, illustrated by numerous specimens, that the repositories are irregular and subordinate to masses of greenstone and serpentine.

The principal works are situated at six leagues from Santiago de Cuba, around the small town of Cobre, built for the use of the miners, and which already contains from five to

six thousand inhabitants. The transportation of the ores to the sea was very expensive before the construction of a railroad, which follows the valley of Rio-del-Cobre, and which gave an impulse to the subterranean works.

The *pitons* and ridges are composed principally of greenstone and serpentines, whose eruptions have elevated and modified the argillaceous schists of an unknown age. The rocks of contact present very strongly marked metamorphic alterations, which resemble all the appearances of the gabbro, whether green or streaked with red. The specimens brought by M. Arrieta, enable us to trace the changes of the argillaceous strata into the greenstones and serpentines. The cupriferous repositories, accumulated near Cobre, are enclosed in green slates, the steatitic nature of which indicates the vicinity of eruptive rocks, which are very profusely penetrated with crystalline sulphuretted iron.

The repositories appear to be irregular repositories of contact parallel to the upraised strata. The manner in which the *pertinencias* (concessions) are disposed, indicates from the first this accumulation which often characterises the irregular repositories, for all the principal mines are concentrated within a rectangle of 1200 yards by 600, and not disposed in lines, as when we have to do with true veins.

Among these repositories, that of Isabelita presents forms very definite and expressive. It is a kind of chimney, in short, an "*erect mass*," as it would be called by German miners. It has been mined to the depth of 180 yards. This repository, according to the expression of the miners, sinks like a nail into the ground, and seems to enlarge in depth.

The vein-stones which filled the repository along with the steatitic matters, which appear to be derived from the enclosing rocks, are crystalline quartz, dolomite, and carbonated lime. These vein-stones (*gangues*), often pure, form crystalline *magmas*, mingled with copper pyrites, which is the normal ore; they are often eliminated by the argillaceous *gangues*, which are penetrated with crystals of iron pyrites, rather than with copper pyrites. Lastly, the hydroxides of iron, penetrated with native and oxidised copper, everywhere

act a somewhat important part in the filling up. The repositories of Blanca, Arrieta, &c., appear to be in similar conditions with respect to position, and identical in regard to composition.

The re-opening of the mines of Cuba dates from 1833. It was commenced by English companies, among which that of Cobre devoted a capital of ten millions of francs to the works. Among the indications which drew the attention of the English companies to these mines, which, in reality, are less prosperous than important in their produce, we must no doubt place in the first rank the traces of the ancient works, and the tradition by which Cobre was celebrated as formerly furnishing copper to the natives, and having, in former times, even given employment to the *Conquistadores*. These are circumstances that would have acted on any mind; but nothing had such weight in the eyes of the English miners, as the existence of numerous ridges, *d'affleurements*, composed of *gossan*. The first captains of the mines who came from Cornwall to Santiago de Cuba, and among others Captain Reynolds, could not find expressions too strong to express their admiration at the sight of these masses of *gossan*, identical with those of Cornwall, but of greatly superior thickness. The native copper, oxidulated and black peroxide, found in the *gossan*, confirmed this first opinion, and they did not hesitate to commence mining operations on a vast and expensive scale. It is in this way that the natives of every country assign a first rank to the indications recognised in their own district. These *Chapeaux de fer* would assuredly have been properly valued by others; but they would not have induced them to adopt such a decided mode of action.

The works, continued for fifteen years with increasing activity, have afforded valuable instruction, which shews what a degree of uniformity exists in the laws which regulate the position, the *allure*, and the composition of metalliferous repositories. In a geognostic point of view, we again find there repositories of contact, and the influence of trappean rocks. With respect to composition, we find the sulphuretted

ores normal in depth, but transformed towards the surface in such a manner as completely to change the appearance of the repositories. The sulphurets of iron, by decomposing, have streaked all the *gangues*, and sometimes the rocks, with ochrey tints producing the characteristic gossan; the ores of copper are transformed either into the state of oxidules, among which we find the cubic and capillary varieties, or into the state of native copper, of which concentrations in masses have been mentioned of many quintals in dimensions.

To this example of copper repositories connected with the trap rocks of Cuba, we may add a second which occurs in North America.

The region which forms the shores of Lake Superior, on the south-west and north-west, appears to have taken a prominent place in the mining of copper ore. This region is formed principally of traps, which have upraised and traversed the sand-stones, whose age is still uncertain, and which Mr Jackson has referred to the old red sandstone. Kewena-Point, which forms a very salient cape on the southern shores of the lake, is the part of this still thinly-inhabited region which has been most carefully examined. Mr Jackson, who has studied it, describes the native copper as filling the cavities in an amygdaloidal trap which is arranged in very broad dykes.

Among the particular characters of the metalliferous trap, Mr Jackson mentions the existence of veins of datholite, which intersect the rock, and contain metallic copper in scales; also prehnite, which occurs in veins with analcime, laumonite, and calcareous spar. The copper of these traps is argentiferous, and the pure silver is insulated in small veins and crystalline nodules, in a copper containing from $\frac{1}{1000}$ to $\frac{3}{1000}$. This locality was visited in 1846 by M. de Verneuil: he found mining operations going actively forward, and he brought home interesting specimens, which confirm Mr Jackson's description, and appear to shew that the ore of copper is subordinate to the trappean rocks.

Here, as at Cuba, the knowledge of the repository was anterior to European colonisation; and the savages of Canada had long been in the habit of collecting, among the alluvia

of rivulets, small rounded pieces of native copper carried down by the running waters. These valuable indications, long neglected on account of the difficulties of the countries, have at length been properly appreciated. A colony of miners is distributed through numerous stations, and the small village of Kewena-Point, become the centre of this movement, already possesses a weekly journal, principally intended for the workmen and miners.

The repositories of Lake Superior extend over a very extensive tract of country, since they are also wrought on the north-west banks, which belong to Canada. Their forms cannot yet be considered as defined, for Mr Jackson's description applies only to some particular points; its extension to the whole metalliferous region would be to exceed the probable facts indicated by analogy. M. de Verneuil returned with the idea that these ores were found principally in the veins which traversed both the traps and upraised sandstones. These veins are composed of quartz, calcareous spar, prehnite, and laumonite, containing native copper in scales, dendritic, in small plates, and lastly, in lenticular forms and masses, sometimes so large, that, in the mining of one of these veins, it was necessary to construct a special apparatus for breaking down the copper into transportable fragments.

We cannot, therefore, determine whether these ores are contemporaneous with the trappean masses, or posterior to them; but there can be no doubt that they are intimately connected with the outgoing of these rocks, and that they constitute an additional example, acquired by science, in favour of the relations which we have pointed out.

(To be concluded in our next.)

The Albanians. By HENRY SKENE, Esq. Communicated
by the Ethnological Society.*

The Population of Epirus, Thessaly, and Macedonia.

There are three principal distinctions among the inhabitants of the Greek provinces, still forming a part of the Turkish empire. The Osmaulis, of pure Asiatic blood, and the Greeks, are two of these great families, differing in race and in faith: the third, which is composed of the Albanian nation, is distinct from either of them, with respect to its origin and descent, while it is divided between the two religious sects to which they belong. In habits, appearance, character, and language, the Albanians are also eminently dissimilar from both the Greeks and the Turks; and they side, in faith, partly with the Christians and partly with the Mahometans. These three races now live in close contact with each other; and they are at such constant variance, on every subject which implies the slightest interest in common, that a great political change can alone produce an approximation of feeling among them.

The Turks and Greeks have been so often the subject of the lucubrations of travellers and political speculators, that their characteristics are comparatively well known in the west of Europe. The Albanians have attracted less attention; and, when they have been taken into consideration as a nation, they have generally been misrepresented or confounded with the other inhabitants of European Turkey. The Mahometan Albanians have thus been identified with the Osmaulis, and the Christians with the Greeks; while the ferocious and treacherous character of one of their tribes has been attributed to the whole nation.

The Albanians are divided into four tribes. These are, the Gheghides and Mirdites, the Toskides, the Tsamides, and the Liapides.

* Read before the Ethnological Society on June 7th 1848.

The Gheghides, who boast of having numbered among them such a hero as Scanderbeg, unite, according to the learned topographer of Greece,* “the cruelty of the Albanian to the dulness of the Bulgarian.” They have long enjoyed a greater share of independence, under the Pashas of Scodra, than any other of the Albanian tribes. They are equally good soldiers with the latter, and have preserved more of their natural stubbornness, from the fact of their having been less often employed as such by the Turks. Their country extends from the frontier of the Austrian territory of Cattaro round the Montenegro, which may be considered an independent state; and, following the ridges which unite it to Mount Scardus, it reaches the Herzegovina, while it is bounded on the south by the river Drino. Scutari, or Scodra, is their chief town, and Dulcigno, Alessio, and Durazzo belong to them.

The Mirdites are merely a branch of the Gheg tribe, and they speak the same dialect. They occupy the pashalik of Croja, and their capital is Oros. Many of them are Roman Catholics.

The tribe of the Ghegs and Mirdites are of lofty stature and athletic frame; and their swarthy complexion and black eyes still retain the characteristics of their supposed Caucasian origin. The distinguishing mark in the dress of these two sections of the same family is, that the jacket of the Ghegs is red, and that of the Mirdites is black. Both branches of the tribe are entitled to much credit for their daring disobedience to the tyrant Ali Pasha, when he ordered them to fire upon and destroy the remnant of the Gandikiotes, which he had enclosed in a courtyard for cold-blooded butchery.

The Toskides are the most handsome of the Albanians. They have noble features, with fair hair and blue eyes, indicating the mixture of Georgian blood, which probably flows in their veins: less warlike than their countrymen of the other tribes, their stature is also less Herculean. They are supposed to have derived their name from the Toxidæ, men-

* Colonel Leake.

tioned by Chardin as inhabiting Mingrelia. The country now occupied by this tribe lies to the south of that of the Ghegs and Mirdites, and extends to the river Vojutza. It is called by themselves Toskouríá. Their chief places are Elbassan and Berat, called by the Turks Arnaout Belgrad, in order to distinguish it from Belgrade on the Danube. Tepellené, the birth-place of Ali Pasha, is now included in their territory, although it was formerly considered as belonging to the infamous Liapides. The great despot declared it, however, to be in Toskouríá, and no one dared to gainsay him on a point which affected the respectability of his origin. The women of the Toske tribe are remarkable for their beauty, like those of Georgia, whence they issue, according to the conjecture of some antiquaries.

The Liapides are the worst of the Albanian tribes. Living only by rapine and murder, they offer the most frightful picture of a degraded state of society; and their evil name has sullied the reputation of the whole nation. They infest the roads, plundering the wayfarer, and often ransacking villages. They convert their booty into arms, curious collections of which may be found in their mountain-homes, whither they retire at the end of their roving campaign. They are cruel, fierce, and treacherous,—of forbidding countenances and sinister expression, and short and ungainly in person. Their dress displays the greatest possible want of cleanliness, and they even pride themselves on allowing it to rot on their bodies. They consider this to be a proof of warlike habits, and they boast of a brave countryman being washed only three times, namely, at his birth, his marriage, and his death. Liapouríá, which includes the whole country inhabited by the Liapides, extends as far south as the plain of Delvino, and is composed of bleak and barren hills, feathered with trees only near their base. The proneness of these rude highlanders to lead a life of plunder, and their filthy habits, aided by the great similarity of the names, the *d*, or delta of modern Greek, being pronounced like *th*, have given rise to a conjecture, that they may be the remains of the ancient Lapithræ.

The Tsamides are the most peaceable and industrious of

the tribes, and are devoted to trade and agriculture. The purity of race has been less scrupulously preserved than with the northern tribes, yet they are for the most part fair-haired. They dress with great splendour, their clothes being covered with gold lace and embroidery, and they carry arms like their more warlike countrymen, notwithstanding that they do not make so much use of them. They inhabit the country, watered by the Thyamis, which is opposite the island of Corfu, and the regions about the river Acheron, extending nearly as far as the gulf of Ambracia, on the south. They call their territory Tsamouriá, which, together with the name of Tsamis which they bear, is probably derived from the river Thyamis. The site of the well-known Soali is in this district, as also the ancient Buthrotam, now a small military position seen from the town of Corfu. Margariti, Paramythia, and Philates, are their principal towns.

The existence of a nation in the very heart of Greece, which is totally different from the original inhabitants in manners, appearance, language, and costume, has naturally roused the curiosity of antiquaries, and given rise to much research on the subject of their origin.

The Albanian language being merely oral, the want of written documents renders their history exceedingly obscure, and the silence preserved by the Greek and Byzantine writers on the subject has reduced the data within a very narrow compass. They are called Arvaniti by the Greeks, and Arnaout by the Turks, both names being derived, along with that of Albanians, from the Albanes, an ancient people of the shores of the Caspian Sea, which may have incorporated itself with the Illyrians. The town of Elbassan or Albanopolis in Illyrian Macedonia, took its name from them, as it is supposed to have been built by a horde of these Asiatic barbarians, who were driven to the coast of the Adriatic by the advancing tribes of the east. In their own language they call themselves Skipetar, which name bears some affinity with that of the Skitekip, mentioned by the Armenian geographers as inhabiting a territory near the Caspian. One of the best authorities* on the subject compares the name of Skipetar with

* Colonel Leake.

that of the Selapitani, a people of Illyria, noticed by Livy.* The modern denomination of Liapides may be derived from this ancient tribe, rather than from the still more ancient Lapithæ, as the name becomes almost the same when the first two letters are suppressed, and the termination, which is always variable, altered. A similarity of names, however, is but a feeble indication of the origin of a people or town, especially in a country where so many dialectic changes have taken place, and it often leads into error. For instance, there is a village near Elbassan, which bears the name of Pekin, without the slightest difference from that of the great city of the Celestial Empire; but it cannot be said, even by the wildest etymologist, to be inhabited by a people in any way kindred to the Chinese.

Another hypothesis holds that the Albanians derive their origin from Alba, in Italy, and that they are the descendants of a colony of the Prætorian guards, dismissed from Rome, by the Emperor Septimius Severus, for having been accessory to the assassination of Pertinax. Their dress, the words coming from Latin roots, which are to be found in their language, and a vague tradition prevalent among themselves, support this idea. Chalcocondylas thinks that the Albanians came from the other side of the Adriatic.† But, as Justin says, that the Albani of Asia were originally brought by Hercules from Italy,‡ the Albanians may have been first Italian, and then Asiatic, although their migration, in this case, must have been much anterior to the time of Septimius Severus. The Albans of Asia, mentioned by Tacitus, occupied the modern country of Shirvan.

Little is known about them, however, previously to their occupation of parts of Macedonia and Epirus, excepting that they entered these provinces from Illyria, and nothing else has hitherto been proved on the subject. They are supposed to have overrun Epirus about the time of the fall of the Byzantine Empire. In advancing towards the south, they also spread over the greatest part of Greece Proper, and many villages of the Morea are Albanian. Indeed, with the exception

* *Lib. xlv., c. 26.*† *P. 13.*‡ *xlii., p. 3.*

of the Mainotes or modern Spartans, the most warlike communities of Greece, such as the islands of Hydra and Spetzia, are formed of this nation, and not of Greeks. Attica, Argolis, Phocis, and Bœtia, are likewise all peopled by them, and there are Albanian colonies even in Calabria and Sicily.

The Albanians call their language Skipt. It is totally different from the Turkish, Greek, and Sclavonian dialects, and it contains a great number of words, closely resembling the Spanish, French, and Italian languages. This would imply that they had undergone some process of amalgamation with the remains of Roman armies. If this had not been really the effect of their descent from the Prætorian guards, it might be attributed to an admixture with the troops of Roger, king of Apulia, who fled to these mountains, and took refuge there. Some of his soldiers may have remained as settlers. The Albanian dress, also, is an exact antitype of that of the Roman army, with the exception of the helmet, which has been replaced by the red skull-cap, and, of the coat of mail, which is imitated by the close embroidery on the jacket. There are, likewise, Gothic words in the Albanian language. These must have been derived from the incursions of Alaricus, in the fifth century, when his Goths made themselves masters of Epirus. It is recorded by Procopius,* that Goths were to be found settled in Dalmatia, when Justinian forcibly annexed that country to the Roman Empire. Some of them may, therefore, probably have remained also in Albania. Now, the ancient Illyrian language was as completely distinct from the Greek tongue, and, if it is not now extant in the form of the Skipt or Albanian, it must be concluded that it has totally disappeared; which is hardly credible. There is no record in history of the extinction of the Illyrian language and people. If, then, the modern Albanians came directly from Alba, in Italy, as some assert, what can have become of that ancient tribe and dialect? The first mention of the Albanians, by the Byzantine historians, although cursory and imperfect, represents them as they now are; and Ptolemy, the geographer, who is the first of the ancient

* De Bell. Goth., lib. i., c. 5, 7, 16.

authors to notice them, distinctly places them in Illyria.* Anna Comnena makes the next allusion to them;† so that history is totally silent on the subject of this people during ten centuries. It appears, however, that they were known, at a much more remote period; for Dion Cassio, in enumerating the Roman conquests, implies that he knew of another Albania. Therefore it is impossible to assign a later date to their settlement in Illyria, with any degree of plausibility, as some do, because this proves that they had then already separated from their mother tribe in Asia. They had probably become incorporated with the ancient Illyrians, and both races are now represented by the modern Albanians. As the remains of the Illyrians, they have perhaps altered less, during this long succession of ages, than any other people of Europe. The study of this tribe is, therefore, the more interesting, inasmuch as it is almost an initiation into the habits and condition of a nation of past time, while much remains, even in their physical appearance, to recal the admixture with a still more ancient Asiatic tribe. This is corroborated by one of the most intelligent and also learned of the English who have seen this people.‡ He says, that “the features of the Albanian, his narrow forehead, his keen grey eye, small mouth, thin arched eyebrow, high cheek-bones, and pointed chin, strongly mark a Scythian physiognomy.”

After Anna Comnena, the first mention of the Albanians, in the middle ages, is by Nicephorus Bryennius,§ who describes them as having formed part of the army of Nicephorus Basilaces, when he rebelled against his Emperor Nicephorus Botaniates, and was vanquished and taken by Alexius Comnenus, in the year 1109. They next received the aid of the Normans against the Greeks, and Robert Guiscard, who led them, together with his son Bohemoud, took Durazzo, Ochrida, and Jannina.|| Durazzo was well defended by George Palæologus, who waited for the coming of Alexius Comnenus, the father of the historian Anna Comnena. Again,

* Ptolem. *Geog.*, lib. iii., c. 13.

† *Dr Hughes.*

§ *Lib.* iv., c. 27.

† *Lib.* xiii., p. 390.

|| *Anna Comnena*, b. 5.

in the end of the twelfth century, the Norman kings of Sicily, with their relatives the princes of Taranto, formed permanent settlements in Albania, under the Byzantine emperors, Andronicus Comnenus and Isaac Angelus. The Albanians were thus early connected with the natives of the west. The Crusades next left a sensible impression on this people, as their ports were constantly resorted to by the Frank chiefs, during at least a century and a half; and Durazzo, in particular, was the depôt of the crusaders. In the beginning of the thirteenth century, when the oriental empire fell to pieces, on account of the occupation of Constantinople by the Franks, a principality of Albania was founded by an illegitimate son of one of the Comneni, named Michael Angelus,* and it existed for more than two centuries, under the title of the Despotate. Jannina was the capital of this state, and Albanopolis also became one of its principal towns. Theodore Lascaris the Second, emperor of Nicea, sent a Prætor to the latter place, in the year 1257, hoping to recover it; but the Albanians preferred the protection of the despot to that of the emperor, and the prætor, who was the historian Acropolita, was obliged to abandon it. In the same century, they plundered the city of Durazzo, which had been destroyed by a violent earthquake; but they afterwards rebuilt it themselves. Pachymer, who records this in his history of the reign of Michael Palæologus,† calls them Albanians and Illyrians indiscriminately; and he says that they enjoyed acknowledged independence of the Greek emperor, and were allies of Charles king of Sicily, who then occupied the island of Corfu and the town of Kanina, anciently Bullis, near Aulon. In the year 1294, Philip, duke of Taranto, the son of Charles the Second, king of the Sicilies, having married the daughter of the despot Nicephorus, received possession of some territory in this country, and called himself Lord of Albania.‡ This title descended to his brother and nephew, but these Latin princes never enjoined much authority on this side of the Adriatic. The Albanians are next

* Nicetas, *Annal. Baldwin*, c. ix., p. 410.

† *Lib. vi.*, c. 32.

‡ *Ducange, Hist. de Constantinople*, lib. vi., c. 16; lib. vii., c. 1; lib. viii., c. 3A.

mentioned by Cantacuzenus,* as having aided Andronicus Palæologus, in his struggle with his grandfather, in 1327, and as having submitted to him, in number about 12,000, when he, being then sole emperor, made an incursion in Illyrian Macedonia against some rebels of their race. The historian says, that it was in Thessaly; but it is more probable that his knowledge of geography was deficient, than that the Albanians were ever to be found in Thessaly. The same emperor took advantage of the death of the despot John, in the year 1338, and the minority of his son Nicephorus, to revenge himself on the Albanians, for their frequent attacks on his towns, and to overthrow the despotate.† In this he was reinforced by a body of Asiatic Turks, which was the first appearance in Epirus of the future lords of the country. Two Albanian chiefs, named Balza and Spata, became formidable to the Byzantine empire about this period, as is related by the historian Chalcocondylas. Towards the commencement of the fifteenth century, the Albanians came under the rule of a sovereign from the west of Europe in the person of Charles Tocco, who was made despot by the Emperor Manuel Palæologus. He was one of the Frank princes of the Ionian Islands, and he took the independent possession of Epirus Proper and Acarnania from them.‡ The Turks now commenced their invasion of Albania, although the first battle which had been fought against them, dated as far back as the year 1383. It took place near Berot, and the Albanians were totally routed by the army of the Sultan Murat the First, their general, the only son of Balza, being killed on the occasion. By the year 1431 they were nearly subdued by the Turks, although their total reduction was warded off for some years longer by the brave Scanderbeg and his father-in-law Arianita Topia. Their last struggle was the siege of Scodra, which was described by a native and eye-witness, Marinus Barletius, in a Latin publication, dated at Venice, 1504. The defence was conducted by a Venetian general, and the attack by Mahomet the Second himself.

* Dueange, *Hist. de Constantinople*, lib. i., c. 55.

† Cantacuzenus, lib. ii., c. 32.

‡ *Lib. iv.*, p. 112, 113.

The Albanians displayed a degree of gallantry worthy of their warlike name, in baffling the utmost efforts of a greatly superior number of troops during a whole year, until famine reduced them to the necessity of yielding. The Venetians then stepped in to protect them, and obtained for them an honourable retreat to Venice as refugees, while the town was given up to the Turks. Since then, the Ottoman dominion over the Albanians has been nominally undisputed, but the authority of the Sultan has never been sufficient to enable him to suppress the spirit of revolt which is still strong within them.

This is nearly all that is known of the history of the Albanians, and, although it is uncertain and obscure, still several heroes of this race have arisen to adorn its pages. There is first the great Scanderbeg; then the more ancient Balza and Spata; there is Ali Pasha of the present century; and in the last, Ghalil or Patrona. The latter headed a sudden revolution which overwhelmed the capital in 1730, and he became absolute master of Constantinople, as recorded by Lord Sandwich.

Many communities of Albanians, which were formerly Christian, have become followers of Mahomet. Some of these were forced to become apostates by Badjazet, their conqueror, very few having had the constancy to resist this conversion by means of the sword. There were, however, instances of fidelity to the Cross, under the most difficult and trying circumstances, the most remarkable of which were the Souliotes, Chimariotes, and Parganotes, who remained faithful to the Greek Church, and the Mirdites, to that of Rome. Others again changed their religion from motives of interest and ambition. One inducement to adopt the Mussulman faith, which was held out to the Albanians by the Turkish government, was in the shape of a law, securing their property to each family which should bring up one of their sons as a Mahometan. Many proselytes were thus gained, and the succession of land was diverted from the *Christians* to the Mussulmen. Again, soldiers by necessity and from choice, the Albanians could attain rank and power,

only through a conformity of faith with their military superiors ; while religion sat so lightly on this class of the population, that it was of little consequence to themselves which rite they followed, as they were never strict in the observance of any form of worship. This was not the case with the Greeks of Albania ; for not only Christianity seems to have taken a much deeper root in them, but also their prospects in life did not depend so immediately on a recantation of religion. The adoption of Mahometanism was certainly advantageous, in a worldly point of view, to the whole Christian population of European Turkey ; but the pursuits of most of the Greeks did not render them exclusively dependent on it for their welfare, as occurred with the Albanians. More addicted to commerce, the Greeks cherished rather any connections which they could form with Western Europeans ; or, when induced by vocation or persecution to become soldiers, they preferred the life of the free Klepht to that of the organised Armatoli bands. Their religion was then optional, and they rarely became renegades. This tendency evidenced the natural breach which existed between the Albanians and the Greeks ; and the Turks were wily enough to foresee the advantage which they might derive from it by making use of the former against the latter. Indeed, it is an undoubted fact, that the Turkish government succeeded in keeping Greece in subjection, up to the time of the revolution, solely by means of the Mussulman Albanians. Gratitude has not been the recompence of the latter, for the Osmauli despises the Mussulman Skipetar, even more than he does the Christian Greek. They have earned the just reward of all traitors and renegades, having betrayed their country and renounced the true faith. A curse seems to have settled on this unhappy people ; and they deserved it for the rejection of that Gospel which was given to them by St Paul himself, before their descent into Epirus. For the great Apostle of the Gentiles preached “ round about unto Illyricum.”* Their present state proves that they have inherited

* Romans xv. 19.

the doom which was entailed on them by their apostate forefathers. Unhappy in their faith, and mistrusted of both Greeks and Turks, there is little doubt, however, that they might again be restored to Christendom, were the Albanians, who have not abandoned the cross for the crescent, admitted to equal privileges. There are still many of the latter class, as one of the best authorities on this subject * gives it as his opinion, that only one half of the Albanian nation has relinquished their fidelity. Christianity seems, however, never to have taken a very firm hold on this race, which is morally and intellectually, if not in strength and physical courage, greatly inferior to the Greeks. Their interests dictated their apostasy; and however unworthy the motive may be, a similar agency may lead back these lost sheep to the fold. The very readiness which many of them shewed to adopt Islamism, is an earnest of their easy recantation and return; and, were the allurements of military advancement to be equally the right of every distinguished soldier, whether Moslem or Giaour, the Mahometan Albanians would probably again become Christians. This would most likely be the first effect—and it is no paltry or insignificant one—of the emancipation of the latter in Turkey, and of the establishment of a complete system of general and mutual religious tolerance, provided always that it is enforced, and does not remain a mere project on paper, unseen and unfelt in real life. A radical change in this, as well as in their social and political circumstances, would certainly afford tranquillity to these restless and rapacious tribes, which, in their present state, are constantly at war among themselves.

An incident occurred about two months ago, which illustrates the actual condition of society in Epirus, while it is also highly characteristic of the primitive and patriarchal manners of the Albanians. A feud had existed for some time between two villages of the Tsami and Liapi tribes, and various acts of reciprocal vexation had kept it alive, without its having exploded, until now, in open hostilities and blood-

* Colonel Leake.

shed. These were produced on this occasion by the following circumstance. A Tsami shepherd, being alone on the hill, was overpowered by a party of Liapides, and his flock of sheep was driven by the latter to the wild mountains of the Chimara. A detachment belonging to the village of the Tsami was bold enough to enter this rugged and hostile country in search of the stolen sheep, or of revenge. They met a number of Liapis, inhabitants of the obnoxious village; the sheep were demanded and refused, a volley of abuse ensued on both sides, and the signal for action was given. The manoeuvres consisted for some time in their favourite mode of fighting, which resembles the service of riflemen; they fired at each other from a considerable distance, and sheltered by trees and rocks. But emissaries had been dispatched, at the commencement of the fight, for succour by both contending parties, and in a few hours hundreds were engaged. Not many, however, had been killed and wounded as yet, considering the mode of skirmishing which was going on, but in a short time they would have thrown down their long guns and used their pistols and yataghans. The Albanians are in the habit of rushing upon each other with loud shouts, when their fury is lashed into charging order by a few successful shots. On this occasion, before they had come to close quarters, several of the old men of the respective villages had come to the spot, and one of the Liapi tribe, who was respected for his age and wisdom, called out that he demanded a parley. It was immediately granted, and in a few minutes the scene was totally changed. Ten or a dozen of the patriarchs of both tribes were now seated on the ground, smoking their long pipes and discussing the terms of peace in the most solemn manner, while the palicara or fighting men stood around them, leaning on the muzzles of their guns, looking fierce at each other, and twisting their long mustachios. The killed and wounded of both parties, being but few in number, were already in the hands of the women, who are never far distant from a scene of conflict; and, on comparing notes, it was found that the respective tribes had suffered an equal loss in this way. The old men of the Liapides then *tendered an offer of restoring the stolen flock of sheep, but*

the Tsami spokesmen demurred, on the plea of the proverbial bad faith of the former clan. They therefore asked for hostages, or security in money. None of the latter article was forthcoming, so the Liapis offered an amount of solid silver equalling thirty okes, or nearly ninety pounds weight. This was accepted as a pledge, and the one tribe had such a degree of confidence in the oath and honour of the other, that they agreed not only to leave their property in their hands, but also to disarm themselves by doing so, for the silver, which was of much greater value than the sheep, consisted in the mountings of guns and pistols, in cartouch boxes, and in hilts of yataghans. The oaths were sworn, the silver was handed over, and the late combatants separated, amicably wishing each other lives of a thousand years. A few days later the sheep were found at sunrise quietly grazing near the Tsami village whence they had been stolen; and the silver was immediately deposited in a ruined church half way on the road to the Liapi village. Thus terminated the feud for the present, although the feeling of hostility has very little abated, and will again burst forth in the same way at the first opportunity. The Turkish government took no notice whatever of this affair.

An often-quoted author* says of the Albanians, that "they are in the constant habit of either warring upon each other, or of hiring themselves to some powerful chieftain of Albania, or of seeking their fortunes as mercenary troops in other parts of the empire. Although preserving a marked distinction from the Greeks, in form and physiognomy, having light eyes and high cheek-bones, they resemble very much in character and manners, the natives of the more mountainous and independent districts of Greece. They possess, perhaps, more evenness of conduct, more prudence, more fidelity to their employers, and, at the same time, more selfishness, avidity, and avarice; but there is found among them the same rigid observance of religious prejudices, the same superstitions, the same active, keen, and enterprising genius, the same hardy, patient, and laborious habits." This is certainly a por-

* Colonel Leake.

trait drawn from the life, and it is strikingly resembling, although there is one point which does not now appear to be an exact copy of the original, but the lapse of years since the picture was painted may account for the discrepancy. The valuable work,* from which the extract is taken, was published more than thirty years ago, and then the Albanian may have been more wedded to "religious prejudices and superstitions" than he is now. It is a sad state of society for the century in which it exists, and for the geographical position of the country, which is so near the civilised nations of Europe. But even, bad as it is, it fosters many fine qualities in the Albanians, which are brought out by their adventurous life. For instance, they possess great presence of mind when exposed to danger, and in general they know not of the existence of such a feeling as the fear of death. They are strong and fine-looking men, with the exception of the Liapi tribe, and bear in their gait and carriage a consciousness of physical power and determined courage. A well-known traveller* says, when landing in Epirus, "the Albania peasant or soldier, words which, in this country, seem to be almost synonymous, is here seen in the completeness of his national character and costume. Generally masculine in his person, having features which shew him not subdued into the tameness of slavery, and with a singular stateliness of his walk and carriage, the manner of his dress adds to these peculiarities, and renders the whole figure more striking and picturesque than any other with which I am acquainted."

They are devoted and obedient to their chiefs, whom they love, and follow from generation to generation. A species of hereditary and feudal aristocracy thus exists, and its power among themselves is unlimited. The title of these nobles is that of Bey, which originates with the Albanians. Many of this people know no language but their own; and those who can speak Greek are easily recognised by their strong guttural accent. Their conduct to their women is one of the worst traits in their character: they marry, as they would buy a donkey, not to enjoy conjugal happiness, but to

* *Researches in Greece.*

† Dr Holland.

have their fire-wood carried home, and to have their provisions conveyed to and from the nearest market. They are constantly to be seen on the road, riding the horse whose load has been transferred to the back of the master's wife; and the poor creature, bent nearly double as she creeps slowly along, is perhaps knitting a stocking for her husband all the time. This has been remarked by most of those who have visited the country; and one of them* thus describes the state of the Albanian women: "They are in general too poor to avail themselves of the license which their religion grants for polygamy, but are content with one wife, who is chosen like any other animal, more for a slave or drudge than for a companion. They are by no means jealous of their women, nor do they confine them like the Turks and Greeks. The wretched creature of a wife, with one or two infants tied in a bag behind her back, cultivates the ground, and attends to the household affairs by turns, whilst her lordly master ranges over the forest in search of game, guards the flocks, or watches behind a rock with his fusil ready to aim at the unwary traveller. These women are in general hard-featured, with complexions rendered coarse by exposure to all varieties of weather, and with persons attenuated by constant toil and scanty fare. In some districts they meet with better treatment, and are found ready to share the dangers of war with the men, as well as the labours of agriculture."† But the least expression of compassion from a stranger enrages them, for they consider their bondage honourable; and the only disgrace with them is to be without children, or to remain unmarried.

The Albanians are compared with the Highlanders of Scotland, by a writer‡ well acquainted with their present state, and their character and habits, as well as their dress and appearance, certainly bear a strong mutual resemblance. Active and daring, hardy and frugal, they may become the finest light infantry in the world; and, in fact, the Turkish ranks are solely dependent upon them for that branch of their

* Dr Hughes.

† Travels in Greece and Albania, vol. ii., p. 106.

‡ Mr Urquhart.

army. They were first employed as regular soldiers in the time of the Byzantine empire, when the bands of Armatoli were formed ; and the Turks were wise enough to continue this system of militia, for the defence of the many defiles and mountain-passes of continental Greece. They had also the responsible protection of all the roads, when brigandage was rife ; and although the travellers in general suffered robbery equally frequently, yet a strict superior officer could make the system efficacious. A chief functionary under the Turks commanded them, with the title of Dervendji Bashi, from the Persian word *derbend*, or pass ; and it was this post which commenced the extraordinary career of Ali Pasha of Jannina. He made the Armatoli so efficient as road-guards, that highway robbery was effectually put a stop to. One of his expedients to intimidate by example was to cut off the hands and feet of all the brigands whom he captured, and to leave them on the most frequented roads to die of hunger, and the effects of their mutilation. So appalling an example did not, as it is said, require a very frequent repetition, for in a short time the roads became as secure to travellers as those of the most civilised countries ; and a man might have walked in perfect safety, with his purse in his hand, from one end of the province to the other. The terror of Ali's name alone was an invisible *Ægis* to protect him.

Besides the three great families of Turks, Greeks, and Albanians, there are to be found, in the Greek provinces of European Turkey, two other tribes, equally distinct from these and from each other, though infinitely less numerous. These are the Bulgarians and the Vlachs.

The Bulgarians are a race of Slavonian origin, and are supposed by some to have been a tribe of the Huns. Their physical appearance is totally different from that of the Greeks and Albanians. More powerful in form, they are of a heavy build, while their features are coarser, and devoid of the acute and intelligent expression which is so remarkable in the Greek and even in the Albanian physiognomy. The Bulgarians are brave but cruel, strong workmen, but brutal in their habits and manners ; and the best and most advantageous of their characteristics is their aptness for country

labour. They are, in fact, the best agriculturists of European Turkey: diligent husbandmen, they have consequently spread their colonies partly over Thrace, and partially even in Macedonia; although in the middle ages they had extended them over the greatest part of what is called now European Turkey.

The Bulgarians crossed the Danube before the reign of Justinian, and kept constantly pouring down from the vast plains of Poland, Lithuania, and Russia, during the sixth century; and they continued gradually gaining ground in the fine countries of Macedonia and Illyria, until the fall of the Byzantine empire. Their relations with the emperors were those of peace, when it was purchased by the latter, or of hostilities generally successful on their part; and they consequently overran a large part of the empire.* They made a permanent alliance in the year 360, with Michael the Third, which stipulated, by treaty, their conversion to Christianity; and, on the other hand, the grant to them of a tract of hilly country around Mount Rhodope, to which they gave the name of Zagorá, still extant. In the tenth century they are said by the Emperor Constantine Porphyrogeunetus to have occupied even the Peloponnesus, and he dates their possession of it from the time of the Emperor Constantine Copronymus, in the eighth century†. The epitomiser of Strabo, who wrote in the time of Basil Bulgaroctonus, that is about the year 1000, goes further, and gives the whole of Greece to the Bulgarians, whom he calls Scythian Sclavonians. They established their capital at Achris or Achrida, the ancient Lychnides, and, their chief, by name Peter, was dignified with the title of King by the Emperor Romanus, who gave him also his granddaughter in marriage. When this town was destroyed by Basil the Second at the opening of the eleventh century, a treasure was found by him there, amounting to the weight of ten thousand pounds in gold. The Bulgarians had driven the Albanians back to the more mountainous tracts of country,

* Gibbon's Roman Empire, vol. iv., c. 42, 43; vol. v., c. 55.

† Const. Porphyrog. de Them. b. 2 Thema. 6 Peloponnesus.

but the destruction of their capital Achris enabled the latter to gain head again, and it is then that they first appear on the page of history as acting a conspicuous part. The Bulgarians however recovered their power before another century had elapsed, and they extended to the southernmost parts of Epirus; Cedrenus records, in confirmation of this, that they had even taken possession of Nicopolis.* They formed an alliance with the Blacks in the year 1186, and rebelled together against the Greek empire; they succeeded in founding another kingdom, of which Turnovo was the capital.†

The Bulgarians have fallen very much in power, although they have not become incorporated with any of the other portions of the population of European Turkey. They still remain a distinct people, and they occupy different parts of Macedonia, Illyria, and even Thessaly, where they devote themselves solely to agriculture. Many places which were formerly possessed by them, have fallen to the share of the Greeks and Albanians; and the Bulgarians have left traces of their occupation, in the names of these towns, by adding the Slavonian terminations *ovo, avo, ista, itza* or *itzi*.

Their language is a corrupt Slavonian dialect, and their religion is that of the Eastern Christian Church, although some of them have espoused the Mahometan faith. Rude and ignorant, they still seem to retain the same habits which they possessed before their descent from the forests of Russia and Poland; and, with their kinsmen the Servians, Bosniacs, and Croatians, they form a family, totally distinct from the Greeks and Albanians.

The Blacks are chiefly migratory shepherds originally from Wallachia, but now to be found all over Turkey in Europe, and even in free Greece. They possess large flocks, which they move from the hills to the plains, and *vice versa*, according to the season; living on the produce of these, they attempt no species of agriculture or settlement, in general. They still hold, however, several towns and villages, which were taken by them in their first incursions. Well armed and courageous, they are ready to protect their lives and

* P. 628.

† Cantacuzenus, l. 3. c. 10. p. 381; l. 4. c. 22. p. 796.

property, but it is rare that they act on the offensive or become Klephti. The celebrated Catz Antoni was an exception however to this statement; and the Greek revolution also roused them to take a part in it. The Blacks of the towns are good artisans, and the best goldsmiths are of this tribe; they make the silver yataghan hilts and mounting of fire-arms, which the Greeks and Albanians are so fond of investing their money in; and the rough cloaks, called cappa or capotes, are made by them, forming an article of extensive manufacture and exportation.

The Wallachians of Greece or Blacks are first mentioned in history about the eleventh and twelfth centuries; they are noticed by the travelling Jew, Benjamin of Tudela, by Anna Comnena*, and by Nicetas† in the thirteenth century; and the latter author states, that their settlements were on Mont Haemus‡. Towards the end of the twelfth century, when they joined the Bulgarians in their revolt against the weak Emperor Isaac Angelus, they contributed so greatly to the foundation of the second Bulgarian kingdom, that two of their own chiefs, Peter and Asan, were the first of its kings. In the year 1205, under their third king, John, they were instrumental in an eminent degree towards the gaining of the great battle of Adrianople by the total defeat of the Franks, which led to the dethronement of Baldwin, Emperor of Byzantium, and his subsequent death in captivity. When their power was greatest, in the end of the twelfth century, a part of the province of Macedonia, with several forts, was successfully held by Chrysus, one of their chiefs, against the utmost endeavours of the Emperor Alexius Angelus to take them.§ Anna Comnene next represents them as being, in her time, exactly as they are now, a wandering hardy race of shepherds.|| Nicetas calls them cruel, and relates the havoc which they made in Thrace during the reigns of the Emperors Andronicus Comnenus, Isaac Angelus,

* 1. 5. p. 138.

† *Annal. Baldwin*, c. 9. p. 410.

‡ *Annal. Isaac Angel.*, l. 1. c. 4. p. 136.

§ *Nicetas. Annal. Alex. Comnen.*, b. 1. c. 4. p. 299; 1. 2. c. 3. p. 314; 1. 3. c. 1. p. 325, &c.

|| *Lib. viii.* p. 227.

Alexius Angelus, and Baldwin. He says that they had not yet been converted to Christianity,* and this historian wrote about the year 1200. But the Blacko-Bulgarian kingdom was for a time attached to the See of Rome by Pope Innocent the Third, therefore their conversion must be ascribed to some date in that interval. The correspondence on this subject with the Archbishop of Zagorei, alludes to the Italian origin of the Blacks†, and, it seems to have been admitted by all the Byzantine historians, that they were the remains of the Roman Colonies, planted by Trajan in Dacia and Moesia. Chalcocondylas notices the Blacks, in the fifteenth century, as extending from Dacia to Mount Pindus;‡ and their principal town in the present day is Metzovo, situated on that great mountain range.

These are nearly all the data, which have been handed down, with regard to this people, which still exists in the identical state described by the writers of the Lower Empire. Their language appears not to be a Sclavonian dialect, as some have said, but it contains so many words of Latin derivation that a western origin must be assigned to it, in preference to a northern one. It is a singular fact, that the Blacks call themselves in their own patois, Romans. Their total number in the provinces of European Turkey is supposed to exceed half a million; and, during the Greek revolution, they furnished at least ten thousand armed men under Zougas. This leader was formerly the protopalicar, or lieutenant, of their famous chief Catz Antoni, who was put to death in the most cruel manner by Ali Pasha for numberless acts of brigandage. Zougas and his Blacks were the executioners of the unfortunate Gardikiotes, whom Ali immolated to his thirst for revenge.

Some inhabitants of this ill-fated town had outraged the mother and sister of the "Albanian Leopard," about forty years before. On her death-bed, the old woman obliged her two children to swear that they would inflict a bloody vengeance for her insulted honour; and Ali kept his vow. The

* Nicetas Annal., Alex. Comnen, lib. 3. c. 5. p. 337.

† *Gesta Innocentii Tertii*, p. 32. c. 68.

‡ *Laonicas Chal.* l. 1. p. 16.

whole population of the place was drawn by him into an ambuscade, where seven hundred and thirty of them were massacred, and the rest, who had settled or were born at Gardiki after the insult, were sent to Prevesa to be embarked as slaves. Ali was stirred on by the malignant vindictiveness of his sister, who left him neither rest nor quiet until the bloody deed was done. She herself perpetrated the most unheard-of cruelties on the persons of the women of Gardiki, and she had a mattress made of the hair of her victims, on which she slept ever after. Many of the inhabitants who had been inveigled into the town of Jannina under various pretences, were seized and thrown into the lake on the same day; and the place where the others were murdered was built up, when they were all dead, and the bodies were left unburied. Ali had a stone tablet placed over the principal entrance, now closed for ever, with an inscription in Modern Greek, recording the facts, and containing the words, "Thus perish all the enemies of Ali." He fired the first shot himself, as he sat in his carriage at the gate. Several of the principal Gardikiotes having been absent at the time of these events, he found means of laying hold of them subsequently, when he put them to death, and sent their bodies to rot in the same court yard with those of their countrymen. The destruction of Gardiki, a town of six thousand inhabitants, which was condemned never to be occupied again, took place in the year 1812; and it was a monument of private vengeance, unparalleled in history, ancient or modern.

The Ghegh and Mirdite Albanians were intended to have been the executioners, but they obstinately and nobly refused; the Blacks were then called upon to fire, and Zougas having been but lately pardoned, with his followers, for previous misdeeds as Klephti, he thought that it would be unsafe to decline. The usual headsmen in European Turkey are chosen from among Gipsies, who possess skill in this, as well as many other professions of doubtful respectability.

There are a great many Gipsies in these provinces, where they are called Tshingaries, probably a corruption of the *Italian* word Zingari. Several villages on the coast between *Alessio* and *Durazzo*, are inhabited exclusively by these

strangers ; and in the large towns, they are also to be found in considerable numbers. They do not mix, however, with the Greek and Albanian inhabitants, but they establish themselves in the suburbs. The town, in which they are most numerous is Jannina, where there are at least two thousand of them, and Premiti is also one of their favourite resorts. Besides that of public executioners, they exercise the trade of blacksmiths and tinkers, and they also tell fortunes here, as in the other countries of Europe. Constantly on the wing they wander from town to town, and even their settlements are often handed over to new comers of the same race. They are easily recognized by their swarthy colour and filthy habits ; and, despised and maltreated by all classes, more than in other countries, it is only surprising, that they are to be found in such numbers in Turkey.

There are also a great many Jews in Macedonia, Thessaly, and Epirus, but more especially in the capital of the former province, where there is a large community of them of Spanish descent. They are to be found however wherever there is a possibility of gaining money, and the small courts of the Pashas offer peculiar facilities to them, from the monetary transactions which are imperative in a country without a paper currency. One classic publication on the subject of Turkey* gives them perhaps more than was their due by saying, that "every Pasha has his Jew, who is his *homme d'affaires* ; he is let into all his secrets, and does all his business. They are the physicians, the stewards, and the interpreters of all the great men." They are to be found however in great numbers, and everywhere they seem to earn their bread, while some enrich themselves.

Such is the motley population of European Turkey, and such the elements of the future destinies of these provinces. That they may be happy, it will only require the care and consideration of statesmen, enlightened by the laudable wish to improve them, while certain misery, such as they now endure, and possibly violent convulsions in their political state, await them, if matters are allowed to remain as they are.

* *Lady M. W. Montague's Works*, vol. ii., p. 178.

On the Early History of the Air-Pump in England. By
GEORGE WILSON, M.D., F.R.S.E., Lecturer on Chemistry,
Edinburgh. Communicated by the Author.*

In the course of a recent perusal of some of the works of the Honourable Robert Boyle, I have had occasion to study with some attention, the treatises in which he describes the air-pumps which were first employed in England, and the steps by which they were improved. I have been led in consequence to notice, that, in the hands of recent writers, the whole history of the English air-pump has been allowed to fall into great confusion, so that the steps by which the instrument was improved, the periods at which those improvements were made, and the parties by whom they were effected, are all more or less confounded with each other or misstated. The authors of those errors, moreover, are parties justly held in the highest esteem among men of science, as the late Professor Robison, Dr Thomas Young, and Professor Baden Powell. They have been implicitly followed, as might be expected, by writers of less note, and errors have been multiplied, as the erroneous account has been repeated, till the evil has reached a climax in the *History of the Royal Society*, quite recently published by Mr Weld. It is stated in that work, that the Society possesses Boyle's original air-pump, whilst the instrument referred to as such is totally unlike the air-pumps described and figured by Boyle,—is, on the lowest computation, twenty years more recent, as regards the date of its construction, than it is affirmed to be; and probably does not so much as belong to Boyle's century.

Whilst grave mistakes, in reference to the history of the air-pump, have thus been committed by eminent authorities, and those mistakes are justified by reference to an existing instrument, which, if it were what it professes to be, would

* The substance of this paper was read to the Royal Society of Edinburgh, January 15, 1849, and discussed at some length in the *British Quarterly Review* for February of this year. It is now published in full, with diagrams and additional observations.

fully authenticate them : on the other hand, I do not know any work which gives an accurate account of the early history of the English air-pump ; yet the records of the latter are certainly not inferior in interest to those of the early German air-pump, and would form a larger and more important chapter in a general history of the invention and its application. I have thought it, accordingly, desirable to endeavour briefly to correct some of the errors into which the historians of the English air-pump have fallen.

It is in connection with the double-barrelled air-pump that the accepted history of the instrument is chiefly erroneous ; but the mistakes made, in reference to the more complex engine, have ultimately involved in confusion even the authentic records of the steps by which the earlier single-barrelled air-pump was improved. It is impossible, accordingly, to avoid tracing, step by step, the alterations by which the instrument was early brought to a state of no inconsiderable perfection. Those steps, however, were few ; not more, indeed, than three, or at most four. It will conduce to perspicuity, to state at once dogmatically what those successive improvements were, and when they were made.

The history, then, of the English air-pump admits of a simple and natural division into four stages, three of which belong to the seventeenth century, and the fourth to the eighteenth. They are as follow, the dates, as given in the original authorities, being according to the old style.

1659. The construction of a pneumatical engine, consisting of a single-barrelled pump, with a solid piston moved by a rack and pinion, and a globular glass receiver directly communicating with the cylinder, which had an aperture in it, closed and opened by a plug moved by the hand, and playing the part of a valve.

1667. The separation of the glass receiver from the cylinder, and introduction of the air-pump plate, on which bell-jars could be placed and used as receivers. The pump was still single-barrelled, and wrought by a rack and pinion, but with an aperture in the piston, instead of in the cylinder, furnished with a moveable stopper.

1676. The introduction of a double-barrelled pump, with

self-acting valves in the cylinders and pistons, and with piston-rods suspended at opposite ends of a cord passing over a pulley.

1704. The combination of the rack and pinion of the first and second air-pumps, with the two barrels, twin-pistons, and self-acting valves of the third.

I proceed to justify those dates and descriptions, and to consider the authors of the several improvements. As it elucidates the subject under discussion, it is desirable to notice, that Otto von Guericke devised his machine, the earliest of all air-pumps, in 1654. The fame of his experiments soon reached England, and interested no one there so much as Boyle. He had been meditating, like Guericke, on Torricelli's results, and was considering how a vacuum might be best produced on the large scale, when he learned that he had been anticipated. He would likely have succeeded in his schemes; and the probability of this, along with the certainty that Boyle had endeavoured to construct an air-pump before 1659, has led Professor Robison, in his article on Pneumatics, in the *Encyclopædia Britannica*, to claim for Boyle the merit of being an independent, though not the first inventor of the air-pump. "Boyle," he says, "invented his air-pump, and was not indebted for it to Schottus's account of Otto Guericke's, published in the *Mechanica Hydraulico-Pneumatica* of Schottus in 1657, as he asserts, *Technica Curiosa*."* This is certainly complimenting Boyle at Guericke's expense, in an uncalled-for way. The former, who was eminently free from envy, meanness, or jealousy, explicitly declares, in the account of his own first pneumatical engine, that he did not set about the construction of an air-pump till he had heard of Guericke's "way of emptying glass vessels by sucking out the air at the mouth of the vessel."†

Encouraged by the report of Guericke's success, Boyle called in the assistance of Greatrex, a well-known London instrument-maker of the time, whose name frequently occurs

* *Encyclopædia Britannica*, 7th Edition, Art. *Pneumatics*, p. 72.

† *New Experiments, Physico-Mechanical, &c., &c.* Reprinted in Birch's Boyle, edition 1772, vol. i., p. 6.

in Pepy's Diary.* Between them, however, they could not succeed in fashioning a serviceable machine, and Boyle had recourse, some time in the year 1658 (O.S.), to the celebrated Robert Hooke, then a youth of some three-and-twenty, but already remarkable for his great mechanical genius. No drawing of Greatrex's contrivance has come down to us, but Hooke, who had seen it, says in his cutting way, that it "was too gross to perform any great matter."

Greatrex's contrivance having been thrown aside, Hooke constructed for Boyle the air-pump, with which his first series of pneumatic researches was made. It appears to have been commenced in 1658, and finished early in 1659. Boyle's account of it is contained in his treatise entitled "New Experiments Physico-Mechanical, touching the Spring and Weight of the Air, and its effects; made for the most part in a new Pneumatical Engine; written, by way of letter, to the Right Honourable Charles Lord Viscount of Dungarvan, eldest son of the Earl of Corke." The date of this letter, which, when published in 1660, formed a volume, is 1659, which may be considered as the certain date of the first English air-pump. The merit of constructing it should seem to be almost entirely Hooke's. Boyle at least claims very little for himself. In the introduction to his treatise, he mentions that he put both Mr G. (Greatrex) and R. Hooke to contrive an air-pump which should be more manageable than the German one, and free from its defects; and then adds, "After an unsuccessful trial or two of ways proposed by others, the last-named person (Hooke) fitted me with a pump anon to be described."† In a manuscript published by Waller, after Hooke's death, the latter says, "In 1658 or 9 I contrived and perfected the air-pump for Mr Boyle."‡ Boyle, however, had certainly

* He was a man of note in his day, but has his name spelled in so many ways, that his individuality is perilled by the number of surnames attributed to him. Hooke calls him Gratorix; *Waller's Life of Hooke*, p. iii. Birch names him Greatericks and Greatoricks; *History of Royal Society*, vol. i., pp. 33, 45, and 50. Aubrey styles him Ralph Greatrex; *Letters, &c., &c., of Eminent Men of the Seventeenth and Eighteenth Centuries*, vol. ii. part ii., p. 475. I have adopted Aubrey's spelling, simply as the shortest.

† Birch's Boyle, vol. i., p. 7.

‡ Waller's *Life of Hooke*, p. iii.

some share in devising the pneumatical engine. I shall call it, therefore, Hooke and Boyle's air-pump, giving the former the priority as the chief contriver. It consisted, as Boyle said, of two principal parts, "a glass vessel and a pump to draw the air out of it." Fig. 1, copied from the engraving in Birch's Boyle, vol. i., last page, illustrates its appearance and construction. The pump A, had a single brass barrel about 14 inches in length and 3 inches in internal diameter. It is represented apart in fig. 2, which is lettered to correspond with fig. 1. It stood upon a strong wooden tripod, with its mouth turned downwards. The piston or sucker C was solid. The shank or piston-rod had teeth cut in it, so as to form a rack; and was moved by a toothed wheel or pinion E working into the rack, and turned by a handle F, as in the air-pumps of the present day. A hole was bored in the side of the upper end of the cylinder, provided with a plug G, which could be drawn out or pushed in by the hand. This was the only valve in the engine. The object of the inversion of the cylinder was to allow the globular or pear-shaped glass-receiver, H, from which it emptied the air, to be placed in a vertical position above the pump. The receiver had a large opening in the top for inserting objects into it. This opening could be narrowed by a tight-fitting brass ring I, in the centre of which was an aper-



Fig. 2.



ture provided with a brass stopper K, to close it. The receiver terminated below in a narrow neck, cemented into a brass stopcock L, which was ground to fit an opening in the upper end of the cylinder, near to the stoppered valve G.

The figure represents the arrangement of parts, when the pump had completed one exhaustion. The valve of the cylinder G is shut, the stopcock L of the receiver open. L was then shut, G opened, and the piston driven home. The valve was then closed, the stopcock again opened, and the piston drawn down; and so on *ad infinitum*. By reversing the order in which the valve and stopcock were closed and opened, the pump could be made to condense instead of rarefying the air of the receiver. The valve for that purpose was opened, whilst the stopcock was shut, and the piston drawn down, so as to allow the cylinder to be filled with atmospheric air. The valve was then shut, the stopcock opened, and the piston as it ascended condensed the air into the receiver.

The pump must have been wrought very slowly. There was a stopcock to turn, and a plug to pull out or to push in, at each stroke of the piston. There were many apertures which could not be kept air-tight; and the cylinder was small for the size of the globe it exhausted. The capacity of the cylinder was about 126 cubic inches, whilst that of the receiver was 60 wine pints (old measure), or about 1732 cubic inches. It is not surprising, therefore, that Boyle should have had to confess that his air-pump produced a vacuum slowly, that the vacuum was imperfect, and could not be preserved.

The most important points to be noticed about this earliest English air-pump are, that it was provided with one barrel; and that, unlike any later air-pump, the cylinder and receiver were directly connected. It appears to have been partly in allusion to the latter peculiarity that Boyle named his instrument, a point of some interest in the present discussion. Once he refers to Guericke's instrument as "the wind-pump, as somebody," he says, "not improperly calls it." Sometimes, but rarely, he uses the terms "pneumatic pump," and "air-pump;" but the title he preferred for his own instrument was that of "Pneumatical Engine." Others called it the

"Rarefying Engine," and "Boyle's Cylinder;" and it was known over Europe as *Machina Boyliana*, Boyle's Machine. Pneumatical Engine was a well-chosen name. The instrument was something more than a rarefying machine, or vacuum producer. It could be used to condense air into the receiver, as well as to withdraw air from it, as Boyle shewed. Vapours and gases could also be introduced into the globe. It was thus an air, gas, or pneumatical engine. At the present day it would be considered an awkwardly-contrived, ill-proportioned, and imperfect instrument. It taught Boyle, however, and his contemporaries so much, achieved such wonders, was so difficult of construction, and so costly, that he called it the Great Pneumatical Engine. He did not retain it long in his possession. With a rare and noble liberality, he presented it to the Royal Society in 1661,* so that his poorer scientific brethren, who could not afford so expensive a piece of apparatus, might prosecute pneumatics at his cost, and multiply experiments with the great engine.

For six or seven years, accordingly, Boyle turned aside from pneumatic research, and no one took his place, at least in Great Britain. Finding, in consequence, that few new experiments had been made in many years, he resumed his inquiries into the properties of the air, and began by constructing a new air-pump. His account of this, which he distinguished as his "second engine," and of the experiments which he made with it, was first published in the shape of a letter to his nephew, Lord Dungarvan, entitled "A continuation of New Experiments Physico-Mechanical, touching the Spring and Weight of the Air, &c. &c. ; Oxford, 1669." The letter is dated (March 24) 1667, which we may consider the year in which the second English air-pump was constructed, though it may have been finished in the preceding year.

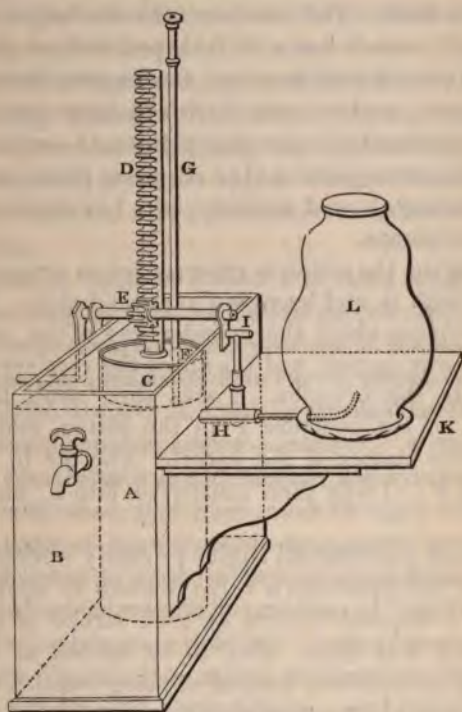
Various considerations "invited me," says Boyle, "to make some alterations on the structure, some of them suggested by others, (especially by the ingenious Mr Hooke), and some of them that I added myself, as finding that with-

* Weld states that this gift was made in 1662 (*History of Royal Society*, vol. i., p. 97). In Birch's History of the Society, the following entry occurs: "1661, May 15.—Mr Boyle presented the Society with his engine;" vol. i., p. 23.

out them, I could not do my work." I have called the second engine, accordingly, Boyle and Hooke's Air-pump.

The second pneumatical engine, represented in fig. 3, copied

Fig. 3.



from Boyle's tract, mentioned above, did not resemble the first in appearance, but, like it, had a single brass barrel A. This stood with its mouth upwards, in a large wooden box or trough, B, filled with water, which rose above the mouth of the cylinder, so that the latter was entirely under water. The object of this arrangement was to keep the leather of the sucker or piston always wet, and, therefore, "turgid and plump," so as to move air-tight in the barrel. The latter had no valve in it. The piston C, which was moved by a rack D, and pinion E, had an aperture F, passing vertically through it, which was closed and opened alternately by thrusting in and pulling out a long stick G, managed by the hand of the operator. But the great peculiarity in the engine was

that the receiver was not directly attached to the pump. A tube H, provided with a stopcock, I, passed from the upper part of the side of the cylinder, through the water-trough, in a horizontal direction, along a wooden board K, covered by a thick iron plate, and was then bent up so as barely to project through the iron. The receiver was no longer a globe or pear-shaped vessel, but a bell-shaped hollow glass jar, L, which was turned with its mouth downwards, like an inverted drinking-glass, and, to use Boyle's homely but expressive phrase, "whelmed on upon the plate well covered with cement." This arrangement of an air-pump plate, and detached bell-jar receiver, I need scarcely say, has been retained in all later air-pumps.

In the figure, the piston is represented as drawn up, lifting the water with it, and leaving a vacuum below. When the piston had risen above the cylinder end of the tube H, the stopcock I, was opened, and the air of the receiver allowed to expand into the cylinder. I was then shut, the stick G pulled out of the aperture F in the piston, and the latter pushed to the bottom of the barrel. The air in it bubbled up through F; G was then reinserted into F, and so on as before.

The second pneumatical engine probably worked as slowly as the first, for there was a valve to close or open with the hand, and a stopcock to turn at each stroke of the piston. The stopcock was liable, also, to be opened at the wrong stroke, and the receiver, instead of being emptied of air, was filled with water. Boyle amusingly notifies, that he had the edge of the iron plate turned up to prevent the water wetting the floor. In spite of these defects and liabilities to mismanagement in working, the apertures admitting of leakage were much fewer than in the first pneumatical engine, and the piston worked tight in the cylinder. Boyle relates in his fifteenth experiment with this machine, that he raised a column of water, in a tube arranged as the long gauge of the modern air-pump is, of more than thirty-three feet. This would still be considered an excellent result with all but the very best air-pumps.*

* A Continuation of New Experiments, &c., p. 45; or, Birch's Boyle, vol. iii., p. 207.

Boyle published the account of the experiments he made with his second pneumatical engine, in 1669, and laid pneumatics again almost entirely aside for seven or eight years. In 1676, however, he began to think of resuming the subject, and he was fixed in his resolution by a visit paid him by a very ingenious and inventive Frenchman, *Denys Papin*, whose name is still connected with one of his many devices, the *Bone-digester*, a peculiar high-pressure steam-boiler, with which he effected strange triumphs in cookery. He has a place, and a high one, long overlooked, among the inventors of the steam-engine, and it will presently appear that he has a claim, latterly quite forgotten, to a high place among the inventors of the air-pump.

Papin came to England in search of some situation which might afford scope for his mechanical genius. Boyle, who had since 1662 been deprived of the services of Hooke, whilst his indifferent health prevented him from experimenting much himself, availed himself of Papin's services, and the latter became his assistant, or rather coadjutor. A new series of pneumatic researches was undertaken; and this was the more readily accomplished, that Papin had brought with him "a pneumatic pump of his own, made by himself," and much superior in efficiency to either of Boyle's pneumatical engines.

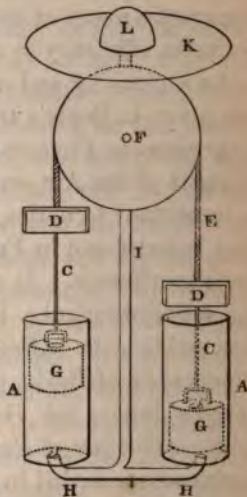
An engraving and minute description of Papin's air-pump are given in Boyle's tract entitled, "*A Continuation of New Experiments Physico-Mechanical, touching the Spring and Weight of the Air, and their Effects. SECOND PART.*" It is important to notice that the substance of this tract was first noted down in French by Papin, who performed most of the experiments. It was then translated by Boyle, or under his superintendence, into Latin, in which the treatise was first published. Afterwards this was translated, under the supervision of Boyle, into English, in which it is reprinted in Birch's Boyle, vol. iv., p. 505. It must be regarded as a joint production of Papin and Boyle's; for several of the experiments recorded in it, on "the preservation of fruits, and of flesh, in liquors," and "also about the coction of meat," "were propounded," Boyle tells us, "by Monsieur Papin, for

a particular end of his own,"* but are, nevertheless, described, with few exceptions, as if a continuous portion of Boyle's special researches.

I cannot give the original date of the Latin or English editions of the tract, but the experiments are all dated. The first bears date July 11, 1676, the last February 17, 1679. Papin's air-pump which he brought with him, is therefore, at least, as old as 1676, which may be considered the date of its introduction into England. Its great peculiarity, as contrasted with former air-pumps, was, that it had two barrels. It was, according to Boyle, Papin's own contrivance. The former, referring to the use he made of the latter's mechanical devices in prosecuting his researches, says,—“Not a few of the mechanical instruments (especially the double pump and wind-gun), which sometimes were of necessary use to us in our work, are to be referred to his invention, who also made some of them, at least in part, with his own hands.”†

Papin's air-pump was a curious machine. It is represented in fig. 4, taken from the plate in Birch's Boyle, vol. iv. (end of the volume), which represents only the working parts of the instrument, without the frame supporting them. It had two pumps standing side by side, with the mouths of the barrels A A, turned upwards. Each of the piston rods C C, terminated in, —as it is styled in the original,—a stirrup D D, attached to its upper end, and the stirrups were connected by a rope or cord E, which passed over a vertical grooved wheel or large pulley F. To work the machine, the exerciser of the pump, as he is called in the original account, put his feet into the stirrups, and holding on, as it should seem, by his hands, to the upper part of the frame-work of the air-pump, or

Fig. 4.



* Birch's Boyle, vol. iv., p. 506.

† Op. cit., p. 507.

leaning against it (for the description is not precise on this particular), moved his feet alternately up and down, as a handloom-weaver does, or a culprit on the tread-mill. The pistons or suckers G G had valves (probably of bladder), opening upwards like that of an ordinary water-pump, and similar valves were placed at the bottom of the cylinders, which were filled with water to a certain height, that the pistons might move air-tight in them. From the cylinders, tubes H H passed to a common canal I, terminating in the air-pump plate K, on which receivers L to be exhausted were laid, as in Boyle's second engine.

The advantages of Papin's arrangement were very great. When a single pump is used it becomes increasingly difficult, as the exhaustion proceeds, to draw out the piston against the pressure of the external air, which comes towards the end to oppose an unresisted force equal to nearly fifteen pounds on each square inch, to the extrusion of the piston. When the piston, on the other hand, is pushed home, it is driven into the barrel with the same force which resists its withdrawal, and is liable to break the valves or injure the bottom of the cylinder. But if the piston-rods are balanced against each other as they were in Papin's machines, so that the one ascends as the other descends, the evils described are obviated. The resistance which the air offers to the ascent of the one piston, is balanced, or nearly so, by the force with which it compels the other to descend, so that the two hang against each other almost *in equilibrio*. A very slight expenditure of force, accordingly, little more than is requisite to overcome the friction of the moving parts, suffices for the working of the pump. A double-barrelled air-pump not only exhausts twice as expeditiously as a single-barrelled one, but does double work for nearly the same expenditure of force.

It may almost be regretted that Papin's and other similar two-barrelled pumps, had not been designated by another name. The title given to them is apt to convey the idea that they excel single-barrelled air-pumps, in the same way that a double-barrelled gun does a single-barrelled gun. In the latter case, however, I need not say, a double effect is gained only at the expense of a double expenditure of time and force in

loading, ramming, priming, and firing the two barrels, which are independent in action though lying side by side. In the air-pump, on the other hand, the working of the one piston renders more easy the working of the other, and diminishes the time requisite for the working of both. It is the connection of the pistons, not the association of the barrels, that effects this result. It might have been well, therefore, if the instrument had been called, not the double-barrelled, but the twin-piston air-pump.

It is not a little singular that Papin's machine should have been overlooked by most later writers. I have not found it referred to in any recent English work of authority, although its curious stirrup arrangement, which has been employed in no English air-pump, might have been expected to direct attention towards it. Papin is mentioned incidentally by Nairne, as an improver of the air-pump.* Dr Hutton in his *Mathematical Dictionary*† mentions Papin's two barrels and twin pistons, but not the stirrup arrangement.

In Shaw's abridged Boyle, the whole machine is described and figured; but Papin's name is not once mentioned, an omission which, at the present day, would be considered inexcusable in an editor or abridger. The double pump must pass with Shaw's readers for an invention of Boyle's, yet even the latter's great name has not kept the instrument in remembrance, a significant proof how little Boyle's works, even when abridged, are read by the very historians of his labours.

Recent writers on Pneumatics having overlooked Papin's machine, whilst they universally acknowledge the importance of two barrels, with the pistons counterbalancing each other, have attributed this great improvement to Boyle, to Hooke, or to Hauksbee, an admirable observer, and very ingenious mechanic, who flourished in the first decade of the eighteenth century.

Professor Baden Powell, in his interesting *History of Natural Philosophy*, p. 235, says:—"Boyle made the first improvement, and reduced the air-pump to nearly its present

* Phil. Trans., 1777, vol. i., p. 635.

† 1796, vol. i., p. 55.

construction." So general a statement in a brief popular treatise, would not in itself, perhaps, call for criticism. It is quoted, however, with approbation, by Mr Weld, and has contributed, along with other things, to mislead him into a curious error already referred to, which, if uncontradicted, will propagate a grave mistake. The point of Professor Powell's statement, lies in the word "*nearly*." In my judgment, he uses it with much too great a latitude, as Mr Weld's interpretation of its significance shews. Boyle's two pneumatical engines, were single-barrelled, awkward in construction, and without self-acting or mechanical valves. They could not be wrought swiftly, and they produced only an imperfect vacuum. Boyle himself ingenuously and ungrudgingly acknowledges that Guericke's pumps exhausted better than his. In compliment to his beautiful Pneumatic Researches, the whole of Europe, designedly passing by the prior claims of the Burgo-master of Magdeburg, called the air-pump vacuum, *Vacuum Boylianum*. Boyle accepted the name, not as a compliment, but as a designation of what he intended, when he used the word vacuum in his treatises. It referred to something between an absolute plenum and an absolute vacuum. It approached to the latter, but fell short of it. It was not Nature's vacuum, the thing which she so much abhorred, but Boyle's vacuum, the best which the Honourable Robert Boyle could produce with his pneumatical engines.

A merit which Boyle so modestly yet earnestly disclaims, no one else need assert for him. His praise is not to have constructed a perfect air-pump, or to have devised one rivalling in excellence the instruments of the present day, but to have made an admirable use of a very imperfect air-pump.

The particular claim, then, set up for Boyle, that he devised the double air-pump, implied in the general claim, that he reduced the instrument nearly to its present construction, may be set aside without further notice. That merit is disclaimed by himself, and ascribed by him to Papin. Hooke and Hauksbee are claimants against Papin, not against Boyle. Professor Robison ascribes the invention of the double pump apparently to both of the former, yet, after all, decidedly to neither. In one place he states that Boyle "was now assisted

by Dr Hooke." "This person made a great improvement on the air-pump, by applying two syringes," &c.* Professor Robison then goes on to describe an instrument identical with Papin's in the arrangement of its valves, and constructed on similar principles. Instead, however, of the stirrups connected by a cord passing over a pulley, the pistons are raised and depressed by a pinion or cogged wheel, working into racks cut on the piston-rods, as the single piston was moved in Boyle's pneumatical engines. No date is assigned to this alleged invention of Hooke's, nor does its describer quote or name any work in justification of his statement. Professor Robison then describes Hauksbee's pump, which is almost identical with the instrument attributed to Hooke, except that it is provided with the former's well-known gauge, an appendage which measures, but at the same time diminishes rather than increases the rarefying power of an air-pump. Throughout the remainder of his treatise Robison refers to Hooke and Hauksbee as if they had been independent inventors of the double pump, the priority, however, being given to Hooke; yet, in concluding his historical sketch, the latter's name is omitted, and the author, as if he preferred Hauksbee's claim, says: "the double barrel and gauge by Hauksbee were capital improvements, and on principle."†

Dr Thomas Young, generally so exact, is not more accurate than Professor Robison. "In the year 1658," says the former, "Hooke finished an air-pump for Boyle, in whose laboratory he was an assistant. . . . Hooke's air-pump had two barrels."‡ Dr Young, a rare thing with him, gives no authority for his statement; and he evidently supposes that the first English air-pump of 1658 was a double-barrelled one. I have already, however, pointed out sufficiently fully, that 1658 or 1659 is the date of Boyle's great pneumatical engine, which Hooke constructed for him, a single-barrelled pump, with a globular receiver directly attached to it.

Erroneous as Dr Young's statement certainly is, it appa-

* Enc. Brit., 7th Ed., Art. *Pneumatics*, p. 80.

† Op. cit., p. 93.

‡ Young's "Natural Philosophy," edited by Kelland, p. 278.

rently derives the fullest confirmation from the announcement made by Mr Weld in his "History of the Royal Society,"* that that body possesses a double-barrelled air-pump, presented to it by Boyle in 1662. This instrument is shewn to visitors, and can be seen at Somerset House. Its barrels are about fourteen or fifteen inches long, and the piston-rods have racks working into an unusually large toothed wheel or pinion moved by a handle. The whole instrument resembles an air-pump of the present day.

It should seem at first sight impossible to question evidence so demonstrative of the true date of the double pump, as that supplied by the existence, in the Royal Society's collections, of an air-pump presented to it by Boyle, and preserved since 1662 in its Museum. Mr Weld's statement, however, will not bear examination. He has himself, without intending it, supplied one of the means of disproving its accuracy. In the first volume of his History (p. 96) he quotes the following passage from the Journal Books of the Royal Society:—"January 2, 1660-1.—The Society again met, when Lord Brouncker was desired to prosecute the experiments of the Recoiling of Gunns, and to bring it in against the next meeting, and Mr Boyle his Cylinder."

In explanation of the last allusion, Mr Weld furnishes a note. "This refers to his air-pump, which, according to Professor Powell, he reduced to nearly its present construction. The reader will be interested to know, that the original air-pump alluded to above, and constructed by Boyle, was presented to the Society by him in 1662, and still remains in their possession. *It consists of two barrels.*" The text and the annotation plainly contradict each other. Had Mr Weld considered, he would have seen that an instrument emphatically called a cylinder, because provided with one barrel, could not possibly be provided with two barrels. The air-pump the Royal Society now possesses is not, then, the one the Society requested Mr Boyle to bring to its meetings in 1660. Neither is it the instrument which he formally presented to the Society in 1661 or 1662; for he had not a

* Vol. i., p. 97.

double air-pump in his possession till 1676, when he made use of Papin's. Mr Weld's date of 1662 can only apply to Boyle's pneumatical engine, completed in 1659. We have direct evidence, however, of the most weighty kind, to shew what the instrument really was which Boyle presented to the Royal Society. In his "Continuation of new experiments Physico-Mechanical, touching the Spring and Weight of the Air; Oxford 1669," already referred to, as containing the description of his second pneumatical engine, the following passage occurs:—"Being obliged to make some journeys and removes, which allowed me no opportunity to prosecute the experiments, I had made no very great progress in my design before the convening of an illustrious assembly of virtuosi, which has *since* made itself sufficiently known under the title of the Royal Society. And having then thought fit to make a present, to persons so like to employ it well, of the great engine I had till then made use of in the physico-mechanical experiments about the air,"* &c. This decides both what the instrument was, and within certain limits the date of its being given to the Society.† It was the first or great pneumatical engine of 1659, and was presented to the virtuosi before their incorporation as the Royal Society, which took place on the 15th of July 1662.‡

Further evidence is not required; but it seems well to notice, since a claim is set up for Hooke, as having made a double-barrelled pump in 1660, or before 1662, that we have what amounts to a disclaimer of this from him. Waller, in his life of Hooke (p. iv.), after quoting a statement of the lat-

* Preface, i., ii.

† According to the statement of Dr Birch, already given (*History of Royal Society*, vol. i., p. 23), the pneumatical engine was presented to the Royal Society more than a year before its incorporation, viz., in May 1661. Weld, in the note already quoted, refers to the gift as having been made in 1662. I know not how to reconcile these conflicting statements of the Secretaries, who both speak with authority, and in reliance on the same official documents. The discrepancy, however, is immaterial to my present purpose, as all parties agree in making 1662 the latest possible date of the presentation of the first air-pump to the Royal Society.

‡ Weld, vol. i., p. 121.

ter's, already given in reference to his share in constructing Boyle's first pump, adds :—" The draught of this air-pump and all its parts, as it was after published by Mr Boyle, I have now by me, designed by Mr Hooke ; and I have heard him say, he was then sent to London by Mr Boyle, to get the barrel [*not barrels*], and other parts for that engine, which could not be made at Oxford.'

In a curious way, also, we have the united testimony of Boyle and Hooke, as to the configuration and appearance of the great engine. During Boyle's lifetime, he employed Faithorne to engrave his likeness.* The portrait is drawn in an oval or medallion, with pieces of apparatus grouped around it. The latter were designed by Hooke, and one of the two most conspicuous instruments is the great pneumatical engine, with a bird in its globular receiver. This drawing is copied as a vignette on the title-page of each volume of Birch's Boyle. Three letters from Hooke to Boyle, of date 1664, containing references to the portrait, and its accompaniments, will be found in the Boyle Correspondence.†

From all that has been said, it will appear, that the double-barrelled air-pump shewn to visitors at the Royal Society's apartments, is as little Boyle's original air-pump, as the famous mace of the Society is Cromwell's bauble. The wreck of the great pneumatical engine may still lurk in some garret or cellar of Somerset House. If so, it will be readily recognised by a reference to the original drawing, and should at once be transferred to a place of safety and honour. There is too much reason, however, to fear, that the original air-pump, like the Dodo, has long been extinct.

An ominous announcement of Mr Weld's makes this too probable. In a comment on the state of the Royal Society's museum or repository in 1767, he says :—" There appear to have been a great number of models of machines and curious

* Faithorne was a celebrated engraver and draughtsman of the period. His portraits of Cromwell, Cowley, and other celebrated men of the times of the Commonwealth and Restoration, are well known and highly prized by collectors.

† *Birch's Boyle*, vol. vi., pp. 487, 488, and 501.

instruments, and it is a matter of regret that these have not been preserved *intact*, as they would now form a collection of undoubted interest."* From this statement it is plain that we may fear the worst. None, however, of the present curators, or members of the Royal Society, nor their predecessors, for more, probably, than a century, are responsible for the disappearance of Boyle's air-pump, if in truth it is lost. Nor would it be fair, when all things are considered, to blame Boyle's contemporaries, or immediate successors, or to accuse them of indifference or neglect.

The instrument was presented to them, not as a curiosity or relic, but as a machine to be freely used for the performance of experiments. The following extracts, made *verbatim* from the first volume of Birch's History of the Royal Society, will prove how highly it was prized by the members. The earlier references shew the interest taken in the air pump before it came into the Society's possession.

166⁰₁. January 2. Mr Boyle was likewise requested to bring in his cylinder, and to shew, at his best convenience, his experiment of the air (p. 8).

February 13th. The Danish Ambassador visited the Society, being introduced by Mr Evelyn, and was entertained with experiments on Mr Boyle's air-pump, &c. (p. 16).

1661. March 18th. Mr Boyle was requested to remember his experiment of the air (p. 19).

March 27th. Mr Boyle was desired to hasten his intended alteration of his air-pump (*ibid.*).

May 15th. Mr Boyle presented the Society with his engine (p. 23).

166¹₂. January 29th. The Genoese Ambassador gave the Society a visit, and was entertained with the sight of Mr Boyle's air-pump (p. 75).

February 12th. Dr Wren proposed to try a watch in Mr Boyle's engine (p. 76).

April 30th. The experiments, agreed on for the next

* History of Royal Society, vol. ii., p. 43.

meeting, were the exercise of Mr Boyle's engine, &c. (p. 82).

May 7th. Mr Boyle's engine was exercised on the arms of several of the members of the Society, who found, that the air being pumped out, their arms were drawn into the receiver (*ibid.*).

1662. *July 30th.* The operator was ordered to carry Mr Boyle's engine to Mr Oldfield, in order to make the top of the cylinder of it, and the sucker to meet together (p. 102).

1663. *April 8th.* The operator gave an account of a tench tried in the pneumatic engine, &c. &c. The like experiment was tried upon two young eels, but they seemed not sensible of the exsuction of the air (p. 216).

Those are a few of the many references to the first English air-pump which occur in the early records of the Royal Society. From them, it will appear, that the great pneumatical engine was employed by the members, till other and better air-pumps came into use, and were at their disposal.

During Boyle's lifetime it would not be valued as a memento or relic; and when we consider through how many vicissitudes the Society has passed, how often it has had to shift its quarters, and how limited its means of accommodation were for a long period, we cannot much wonder if the pneumatical engine was forgotten at some of the Society's removals, or deliberately abandoned to its fate. We may at least, with great reasonableness, assume, that its fragile glass receiver had been broken to pieces before the close of the seventeenth century. The strange inverted cylinder, and awkward wooden tripod, which would then remain, would not readily be recognised, even by instrument-makers, as the exhausting apparatus of an air-pump.

Only one, or, at most, two engines like it, appear to have been constructed,* and these did not long remain in use, so that very few, after the lapse of fifty years, would be fami-

* *Continuation of New Experiments, Part i., 1669. Preface, p. ii.*

liar with the appearance of the great pneumatical engine. After Hooke's death, in the beginning of last century, there was none living likely to have a special interest in its preservation. Some zealous curator, if it then existed, would sweep it into a corner, or sweep it away as lumber. Mr Weld's original air-pump results from the combination of two quite unconnected facts; the one, that Boyle gave the Royal Society an air-pump in 1661; the other, that the Society now possesses an old air-pump. That the latter is not the original great pneumatical engine does not admit of doubt. Boyle, moreover, is not known to have presented more than one air-pump to the Royal Society. Unless, therefore, there is evidence of the most explicit kind to shew that the double-barrelled instrument was once the property of that philosopher, we must hold it as highly unlikely that it ever was in his hands. It will presently appear, that it probably does not belong to his age, but is an air-pump of the eighteenth century.

A few words will conclude the early history of the English air-pump. Papin's double pump does not appear to have been directly copied by English instrument-makers, so that its stirrup arrangement, in particular, was practically unknown. I have been unable to find any allusion by Hooke himself to his having constructed a double-barrelled air-pump; nor has any reference been given by those who affirm that he did, to any existing instrument, or drawing, or account of it. It would be dangerous, however, to assert an absolute negative on this point, for Hooke's papers are very numerous, are immethodically arranged, ill edited, and not easily consulted. Yet, had there been any notorious declaration of Hooke's on the subject, it would have been quoted by those who favour his pretensions. On the other hand, Waller, who sets up a well-founded claim on Hooke's part to Boyle's air-pump, limits the claim to the one-barrelled pneumatical engine of 1659. Boyle and Hooke were, from first to last, attached friends, and in constant communication with each other. Had Hooke devised a new air-pump, Boyle was the first person to whom he would have shewn it; and, even if he had not explained its construction to Boyle, the latter could not

have failed to become acquainted with it, through one or more of his large circle of friends and acquaintances. Boyle, however, who acknowledges his obligations to Hooke's ingenuity, in reference to the second as well as to the first air-pump, speaks of Papin's double barrel as something quite new to him, and extols its advantages. If Hooke, therefore, constructed a double pump, it must have been of later date than Papin's machine, with which he certainly was acquainted. It was Hooke who introduced Papin to the Royal Society, May 22, 1679.* They were associated in the conducting of the correspondence of the Society, and must have been much together.† In the report of the Society's meeting for July 17, 1679, it is stated that "the second experiment of Mr Hooke was with the exhausting engine of Monsieur Papin."‡ Unless, therefore, it can be shewn, that Hooke preceded Papin in the construction of a double-barrelled air-pump, the latter is plainly, and with consent of the former, entitled to the entire merit of priority. Hooke did construct two pneumatical engines before he became acquainted with Papin's machine, but they had no resemblance to it. The one was a condensing engine, of which a minute description is not given.§ Its consideration is foreign to my present purpose. The other was a very curious machine, which has escaped the attention of the historians of the air-pump. It is referred to by Birch, in his *History of the Royal Society*, as "a new way of making a vessel for extracting the air, so large that a man might sit in it."|| Hooke thus described it: "It consisted of two tuns, one included in the other; the one to hold a man, the other filled with water to cover the former, thereby to keep it stanch; with tops to put on with cement, or to take off; one of them having a gauge, to see to what degree the air is rarefied; as also a cock, to be turned by the person who sits in the vessel, according as occasion shall require."¶ This instrument was

* Birch's *History of Royal Society*, vol. iii., p. 486.

† *Op. cit.*, vol. iii., p. 491.

§ *Ibid.*, vol. i., p. 125.

¶ *Ibid.*, p. 467.

‡ *Ibid.*, p. 497.

|| *Ibid.*, vol. ii., p. 463.

constructed in 1670-1, and Hooke tried various experiments on himself with it, as the Journals of the Society record.* No minute reference occurs to the exhausting part of the apparatus, nor is any allusion made to it as having been furnished with two barrels.† There is no evidence, then, extant, or hitherto, at least, made public, to shew that Papin's double-pump was not as new to Hooke as it was to Boyle.

Hooke (ob. 1702) survived Boyle (ob. 1691) about ten years, and may have constructed a new air-pump after the latter's death; but I have not been able to find evidence that he did.

The first double-barrelled air-pump of English construction, of which, so far as I am aware, a figure and description are extant, is Hauksbee's. They occur in a small quarto, "Physico-Mechanical Experiments on Various Subjects, by Francis Hauksbee, F.R.S." In the preface, the author says, "The Honourable and most excellent Mr Boyle * * * * gave much light into the causes and operations of Nature; and particularly by the invention of that most useful instrument, the air-pump. The principal subject of the following papers is, an account of great and further improvements of this noble machine, the air-pump, and of many new experiments made thereby."

The date of Hauksbee's work is 1709; but it consists chiefly of reprints from the Philosophical Transactions, of papers published in earlier years. All of these papers are

* Birch's History of Royal Society, vol. ii., pp. 463, 467, 469, 470, 472, 473, 476.

† This "air vessel" must, on the lowest estimate, have been of large dimensions. It only provided room, however, for a person sitting; and, perhaps, was suited solely for the reception of its ingenious deviser, who was, according to Waller, "low of stature" and "very crooked." (*Life of Hooke*, p. xxvi.) A very interesting account of Hooke's personal appearance, with an estimate of his character, which has been much misconceived, is contained in a little known work, "Aubrey's Letters and Lives of Eminent Men of the Seventeenth and Eighteenth Centuries." For a knowledge of Aubrey's volumes, as well as for other valuable references, throwing light on the present inquiry, I am indebted to my friend, the Rev. Thomas Baynes, of Bristol, one of the happily constituted few, who combine a knowledge of metaphysics, with a strong relish for the investigation of the higher departments of physical science.

of later date than 1703, after which we may date the pump also. It is not unimportant to notice, that it was not made public, and probably not constructed, till after Hooke's death. Hauksbee speaks of it as an improvement on Boyle's air-pump. Whether he is to be understood as referring to Papin's machine, does not appear; but if familiar with Boyle's descriptions of air-pumps, he could not be ignorant of Papin's. At all events, Hauksbee's pump (the long gauge excepted) is simply Papin's, with the stirrup arrangement and pulley, replaced by racks on the piston-rods, and a pinion, moved by a handle. The advantages which attend the employment of two barrels, with their pistons balanced against each other, so as to be nearly indifferent to the pressure of the atmosphere, are dwelt upon at great length, as if they had been realised in Hauksbee's instruments for the first time. All those advantages, however, are pointed out with as much distinctness in the description of Papin's instrument of 1676. In truth, the excellence of Hauksbee's pumps, did not lie, as Professor Robison thought, in the introduction of any new principles (the long gauge excepted), but in the combination of recognised principles, and in the nicety of the mechanical construction of the pumps. They were a happy union of the best peculiarities of Papin and Hooke's air-pumps. Hauksbee adopted the double barrel, counterbalancing pistons, and self-acting valves of Papin; but replaced his awkward stirrups and pulley, by Hooke's rack and pinion. I am strongly inclined to believe that Hooke's supposed invention of the double barrel, has originated in the observation of his rack and pinion in most modern air-pumps. It should seem, however, according to the evidence hitherto produced, that Hauksbee, not Hooke himself, first applied the latter's device to the double air-pump. Nevertheless, Hooke is entitled to be named in connexion with his own contrivance, and thus he will have a three-fold connexion with the instrument, as deviser of the first air-pump, as one of the devisers of the second, and as the author of the method of raising and depressing the pistons in the fourth. Yet it cannot be denied, that the great merit of the early double pump does not consist in the mode, whatever it be, employed to move

the pistons; but in their mutual twin dependence, and in the arrangement of the self-acting valves. To Papin all this merit belongs. Whether he was the inventor of the instrument he shewed to Boyle, I cannot positively affirm. Boyle understood that he was, and he certainly ranks before any English constructor of a double-barrelled air-pump. Into the history of foreign improvements on the instrument I do not at present enter. Winkler, who was professor of natural philosophy at Leipsic, in the middle of last century, in his *Elements of Natural Philosophy*, gives a good sketch of the history of the air-pump.* Hauksbee, and Leupold, of Leipsic, who was contemporary with Hauksbee, are the only parties to whom Winkler refers as having a claim to be considered inventors of the double air-pump. He makes no allusion to Papin's. M. Libes† states, that Papin and Hauksbee are the only claimants of the double pump; and that Cotes, of Cambridge, a contemporary of Hauksbee, attributed the invention to Papin. There should thus seem to be no foreign claimant against Papin, and no known English one but Hauksbee, whose pump was constructed some twenty years after Papin had devised and published an account of his, which, it seems impossible to doubt, must have been known to Hauksbee.‡

The reader will now understand why I should think it in the highest degree improbable that the double-barrelled air-pump of the Royal Society belonged to Boyle. It is, possibly, a relic of Hooke, and of the seventeenth century; but more probably a memento of Hauksbee, and belonging to the eighteenth century.

* English Translation, 1757, vol. i., pp. 116-119.

† *Hist. des Progrès de la Physique*, 1810-1812, tome iii., p. 56.

‡ Libes exaggerates Hauksbee's merits, ascribing to him the device of "une platine ajoutée à l'instrument" (*Op. et loc. cit.*). The air-pump plate, as I have fully pointed out, was an appendage of the second English air-pump of 1667.

On Marine Dredging, with Notes and Observations, the result of personal experience during the summers of 1846 and 1847.

By ROBERT M'ANDREW, Esq., F.L.S.*

Having been occupied during the past and preceding summers in examining, by means of the dredge, the sea-bottom adjoining our coasts, in fulfilment of my duty as a member of the Dredging Committee of the British Association, and with the view of adding to the imperfect knowledge which we possess of the invertebrate inhabitants of the deep ; it is my intention, on the present occasion, to state some of the more interesting results, with such remarks and observations as they suggest ; but without entering upon a narrative of my operations during the various expeditions I have undertaken, or the numerous difficulties, and even danger, with which these have been attended. It may easily be imagined, that to bring up from their quiet habitation the dwellers at a depth of 500 feet and upwards, while exposed to the heavy swell of the Atlantic, in northern latitudes, where the weather is seldom fine and settled, can be no child's play.

My researches have been principally directed to deep water, at a distance from land, in preference to inlets and sheltered situations, because, in consequence of these last affording abundant results of comparatively easy attainment, there are not wanting others who are willing to explore them ; whereas, few or none appear to combine the means with the inclination for the more arduous service. I may be allowed to add, that any sacrifice I may have made in the pursuit of knowledge has been abundantly compensated by the manner in which my labours have been appreciated by many of the most eminent friends of science.

Although the dredge has long been applied to certain economical purposes, such as the procuring of oysters and marine matter for manure, it is only of late years that attention has been drawn to its great importance as an instrument of scientific research, alike valuable to the geologist and zoologist. Its advantages consist in enabling us to become acquainted with species and forms of animal life not otherwise accessible ; with the circumstances and conditions under which they exist ; and in affording the only correct means of ascertaining the geographical distribution, with the vertical range, as well as local habitat, of the invertebrata inhabiting the bottom of the sea ; also the modifications of form occurring invariably in particular species when obtained from certain depths. It will be seen in a moment how the knowledge of this last fact may be applied in enabling the geologist to come to a conclusion as to the depth at which some of the tertiary and more recent formations have been deposited.

* *Proceedings of the Literary and Philosophical Society of Liverpool, during the 36th Session, No. 14. 1848.*

It is generally known, through the valuable observations of Professor E. Forbes, that in the sea each zone of depth contains its own peculiar species of animal and vegetable life. Of marine animals, some are strictly limited to a particular range of depth; others, and probably the greater number, have their chief development in one region, but are to be found, though more sparingly, throughout the neighbouring regions; while, again, there are certain species which appear to be not at all particular with respect to depth, but are to be met with in all the four zones into which Forbes has divided the seas of Britain. It appears, at first sight, to be a remarkable fact, that individuals of similar organization should live and flourish indifferently under a pressure of only twice, and under one of sixteen or twenty times that of our atmosphere; but, when we take into our consideration the comparatively incompressible nature of water, and that the medium inhabited by the dwellers in the abysses of the sea, is not more dense in any appreciable degree than that immediately below the surface, it is not easy to imagine in what way the marine mollusca can be affected by pressure. It is evident that they do not require the protection of stronger shells, as these are generally thinner and more delicate in deep than in shallow water. There are, doubtless, however, other conditions which must render the depths of ocean unfavourable to the development or existence of animal life; perhaps the most important of these may be the total absence of light; and the fact, noticed by travellers, of the extraordinary transparency of the Norwegian seas, may explain why mollusca frequent greater depths there than in other parts, as is said to be the case.

The most general characters of mollusca obtained from a great depth, compared with individuals of the same species inhabiting shallow water, consist in smallness of size and deficiency in colour. There are also the modifications of form already alluded to, which I brought a few specimens to illustrate—all from the coasts of Zetland—viz., the common whelk (*Buccinum undatum*), from less than 10 fathoms, the same from about 25 fathoms, and again, from 50 or 60 fathoms. It will be observed, that the form becomes more elongated the greater the depth of habitat, which appears to be a law applying only to the particular species. In *Fusus corneus* the very reverse occurs, as it is found invariably shorter in proportion to the greater depth it frequents. The specimens are from 7, from 30, and from 80 fathoms. I have also brought, for comparison, specimens of two common bivalves—*Venus galina* and *Venus ovata*—obtained in shallow water and at a depth of 80 or more fathoms.

After further experience, I see no reason to change the opinion I expressed on a former occasion respecting the relation existing between latitude and depth in the sea, *not* being analogous to that which is found to exist between latitude and elevation on land.

It is well known that the vegetation of the arctic regions is repeated at great elevations in temperate and tropical latitudes, either with the same or representative species; and it has been inferred,

that by a parallel law the northern marine fauna would be found inhabiting great depths in the more southern seas ; indeed the observations of my friend Professor E. Forbes, published in his report upon the invertebrata of the Egæan sea, are, by him, considered sufficient to establish the fact. It may appear presumptuous in me to differ from so high an authority—one who is probably, in every respect, better qualified than any naturalist of the day to form a decisive opinion upon the subject—more especially (and I gladly take the opportunity to acknowledge it), as it is entirely in consequence of his instruction, and guided by his recommendations, that I have been enabled, while following a pursuit undertaken originally for recreation, to render any service to the cause of science. True it is, nevertheless, that my experience does not tend to confirm the above hypothesis ; as I find various species common to the Mediterranean and northern seas inhabiting as great or greater depths in the latter. Also, the analogy does not appear to me to hold good, on account of the great diminution of temperature which takes place on ascending to high elevations in the atmosphere, and the comparatively even temperature of the water at various depths. I am rather inclined to the belief, that each species is best adapted to certain conditions of climate and depth in which it attains its greatest development ; and that the further it is found from its most favourable habitat, either towards the north or south, it will be at a greater depth in order to be removed from the influence of unfavourable climate. I would not at present feel justified in asserting, with any confidence, that such is the case ; and if it be, there are certainly many exceptions in littoral or sublittoral species, which continue to be such wherever they are to be met with, under all circumstances of climate.

Touching the geographical range of the species of mollusca, in order to arrive at a complete knowledge of the subject, it would be necessary to compare together the fauna of every country and region, which is not at present practicable for want of the necessary data, as we possess lists of the mollusca of but few districts, and these more or less imperfect. As far as is possible, with such information as can be procured, it has been done by Dr Philippi, in his valuable work upon the mollusca of the two Sicilies.

It only comes within the scope of my present communication to remark upon the distribution of the lower animals within the limited area of our seas ; and from a desire not to trespass upon the time and patience of the Society, by a dry enumeration of all the species, with their various localities, I will confine myself to the statement of such facts as I conceive most important ; even so I feel called upon to entreat your indulgence, as it will be necessary to mention not a few species, the names of which will be particularly uninteresting to those who have never bestowed attention upon this branch of natural history.

The fauna of the British seas belongs to a division which has

been denominated "Celtic," occupying the intermediate space between the "South European" and the "Arctic" or Northern. It contains some few species which belong to all the three regions, being found both in Greenland and the Mediterranean; many Mediterranean species, which appear to reach the northern limit of their range in our seas, and it also furnishes the southern boundary to many arctic forms of animal life.

Certain of the South European group of mollusca only just reach our coast, not occurring north of the British Channel or the most southern shores of Ireland; as examples of which, I will mention *Lucina pecten*, *Capsa complanata* and *castanea*; *Cardium aculeatum* and *tuberculatum*; *Gastrochœna pholadia*, *Calytrœa sinensis*, *Trochus exiguus*, *Nassa varicosa*, *Pleurotoma*, *Striolata*, and the southern genus *Avicula*. Two species which appear to have their greatest development in the Mediterranean, viz., *Cytheriachione* and *Venus verrucosa*, reach their highest latitude on the coast of Carnarvonshire. Several other well-known inhabitants of the Mediterranean extend only along the western shores of the British isles; being found in the neighbourhood of Cornwall and Scilly; again, in the south of Ireland, and round the west coast of that country to the Hebrides and even Zetland. This is the case with *Solenecurtus candidus*, *Psammobia costulata*, *Lucina spinifera*, *Cytheria minuta*, *Pecten similis*, *Natica sordida*, *Pleurotoma teres*, and *Erato levis*. *Tellina balaustina* and *Arca raridentata* have only been met with in the west of Ireland and the Isle of Skye. It is worthy of remark that these are mostly old species, all but two being recorded as fossil in the tertiary beds of Sicily, and that they are not found in either the British or St George's Channels; whether this circumstance is to be regarded as corroborating the opinion that these channels have been formed by the sea at a recent geological period, I would merely suggest for consideration. Two species of *Neœra*, *N. costellata* and *N. abbreviata*, inhabiting both the Mediterranean and coasts of Norway, are only known in one British locality, viz., Loch Fyne, where they were discovered by Professor Forbes and myself in 1845. Of *Pecten pes felis*, recorded from the Egæan, a single individual, dredged by myself in Loch Fyne, is the only specimen that has been procured alive in our coasts.

I will now proceed to those marine occupants of the arctic or northern division of the ocean, which apparently reach the southern limit of their range at different points within the area of the British seas. Of these, some only extend to the neighbourhood of Zetland and Orkney; as for example *Astarte borealis*, of which I obtained a recent valve off Zetland, and have seen perfect specimens from Spitzbergen; of *Margarita undata*, otherwise only known as a Greenland species, I procured a live specimen near Lerwick. Also *Trochus formosus*, *Fusus albus*, *Certhium nitidum*, with a *Rostellaria* and two species of *Fusus* obtained last summer, but not yet named or described, are doubtless arctic forms, though as yet only known from the Zetland

seas. *Scalaria Greenlandica*, the ordinary habitat of which is sufficiently explained by its specific name, will henceforward take its place among British mollusca, in consequence of my having, in the month of July last, dredged a fragment of it off Duncansby Head, in about 35 fathoms, at the distance of 12 miles from land. Two species, *Margarita carnea* and *Crenella elliptica* are found at Oban, but not further south. The only other British localities that I am acquainted with for the former, are Zetland and Orkney; the latter is met with in the northern Hebrides, but has hitherto been esteemed extremely rare. I found it in extraordinary abundance at Unst, the most northern of the Zetland Islands.

Astarte compressa, *A. elliptica*, *Nucula tenuis*, *Pecten nebulosus*, *Patella ancyloides*, *Cemoria Flemingii*, *Natica Montagu*, *Velutina ovata*, *Chemnitzia rufescens*, *Cyclostrema Zetlandica*, *Rissoa abyssicola*, *Fusus barvicensis*, *Pleurotoma Boothii*, *Trichotropis borealis*, and probably some others, inhabit the waters of the Clyde, where their range appears to terminate. *Ampidesma intermedia*, *Crania Norwegica*, *Terebratula caput serpentis*, and *Lottia fulva*, are present in the Clyde, from whence their range crosses the north channel and extends by the west of Ireland. *Lottia testudinaria*, a species of Iceland and the arctic regions, unknown on the east coast of Scotland, and even in Zetland, is abundant through the Hebrides, and reaches to the north coast of the Isle of Man. *Fusus Bamffius*, a shell of Greenland, is frequent in the neighbourhood of Point Lynas, but I do not believe to be found south of Anglesea. *Emarginula crassa*, first known as a fossil of Sweden, though a living inhabitant of Scandinavia, was discovered a few years ago in the Hebrides and Clyde; and I have very recently received specimens of it, taken alive with oysters on the coast of Carnarvonshire.

From what I have stated, it would appear that the two points on the west coast of Britain, where the greatest change takes place in the species and genera of mollusca, are—the parallel of our most southern shores and that of the Clyde. Respecting the east coast I cannot speak from personal observation, my researches having been limited to the most northern shores of it.

At the time of that important and comparatively recent geological change, when were elevated into dry land those deposits of what has been called the glacial epoch, which we see largely developed in the Clyde basin, the shores of the Irish Sea, including the north portion of the Isle of Man, and of which we have a nearer example in the river bank at Egremont; several northern forms of mollusca, previously distributed throughout our seas, became either quite extinct in them, or confined to particular localities, which were probably less affected by the general disturbance. These tracts, where survive—though somewhat degenerated in certain instances—the representatives of a more ancient fauna of our seas, are situated principally among the lochs and islands on the west of Scotland; but there is

one, a district of considerable extent, off the south coast of Ireland, including what is called the Nymph Bank, where we find *Crania Norwegica* and *Lottia fulva*, actual inhabitants of the Scandinavian seas, as also arctic forms of *Buccinum* and *Fusus*, associated with the most southern species of mollusca that reach our coasts.

The examination of these tracts, the last remaining strongholds (if I may so express myself) in our latitudes of species which abound in a fossil state in the crag and drift formations, furnish evidence that a change is now actually taking place in the fauna of these seas; some species having very recently become extinct, while others are dying out, and promise to disappear entirely at no distant period.

Cemoria Flemingii, a common fossil of the Clyde basin, still flourishes abundantly in the adjoining sea, though it is rare through the Hebrides and in Zetland. *Pecten nebulosus*, likewise a common fossil of the same district, is now only to be found living in any number in a particular spot near the head of Loch Fyne, though dead shells are to be met with in the greatest abundance in various districts where a single live individual is of rare occurrence. *Pecten Islandicus*, fossil in the same beds as the last, has probably become recently extinct in our seas, as there is no living specimen on record, though I have procured it dead in various localities from the Clyde to the north of Zetland.

Nucula pygmaea, a prevailing and characteristic fossil of the drift, and now living in Greenland, is found alive in the sea surrounding the Isle of Skye, but in no other of the Scottish coasts. *Nucula oblonga* and *N. truncata*, supposed to be extinct in Britain, I have dredged dead in the same locality. The neighbourhood of Skye is also remarkable as the only known Scottish habitat of *Arca raridentata*, and *Terebratulula cistellula*, recently discovered living, but before known as fossils of the red crag; also a beautiful new *Comatula*, supposed to be an inhabitant of Norway.

Before concluding, I will once more say a few words upon a subject to which my attention has been for some time directed, namely, the best means of preserving animals and preparations.

Not having been very successful in the use of Goadby's solutions, I last summer engaged the services of Mr Goadby himself, who accompanied me on a cruise of three months. Unfortunately this gentleman was in a bad state of health, and what was most particularly to be regretted, his vision was affected to such a degree that he was unable to decipher ordinary printing or writing, much less accomplish any of those beautiful preparations, in which he had previously been so eminently successful. The objects we procured were, in consequence, only preserved roughly as stores; but even so, under all disadvantages, they are declared by Professor Owen, Carpenter, and other naturalists, who have seen them, to be of great value, particularly the transparent animals, such as *Medusa rhysostoma*, *oceana*, &c., the delicate tissues of which had never before been preserved,

and which, consequently, are not to be seen in any museum or collection. The main ingredient made use of is bay salt, a minute quantity of corrosive sublimate, about two grains to a quart of the solution being added to prevent vegetation. There can be no doubt of its success, provided the necessary care and attention are bestowed; but it is necessary first to use a weak solution, repeatedly changing it to a stronger, till it is nearly saturated with bay salt. The time required for this is the only drawback, as on an expedition, where there would be sufficient employment for a naturalist following the ordinary plan, there would be abundant occupation for another individual in preserving the objects in a way to do them justice. Alum is occasionally added to the solution with advantage, where there is no carbonate of lime contained in the specimen to be preserved, but the use of it requires some practical experience; and indeed no rules can be given capable of being applied generally, as most classes of animals require, more or less, a particular treatment.

On the several Volcanic interferences, which alternate and are concurrent with, and eventually supersede, the depositions of the Old Red Sandstone of the British Isles. By the Rev. D. WILLIAMS, M.A., Corresponding Member of the Geological Society of Cornwall. Communicated by the Author.

If I am right in the views which I have briefly announced in some former publications, that the whole multifarious and Protean family of the so-called "Plutonic and igneous rocks," with their universally-associated trappæan ash and slate relations, are simply volcanic products, commonly submarine, and had their origin in chemically-generated heat (for which by the way I ask for and invoke no imaginary masses of potassium or other unoxidized metallic bases)—chemically-generated heat, perfectly apart from fire or combustion;—that the granite and trappæan vein-like ramifications that so commonly penetrate the rocks which bound them, and have entailed on them, to various extents and depths, the ravages of reduction they now exhibit, in all its stages from perfect fusion to semi-fusion and remote incipient induration.—If those so-called veins, and that amount of alteration, be existing monuments of the processes by which the imprisoned and accumulating high temperature reduced those bounding rocks.—If the different granite, porphyry, or hypersthene bosses, be

so many focal residua of the several volcanic centres ; and their universally-accompanying greenstones, trappæan ash, schists, and slates, successive superfluous rejectamenta of paroxysmal crater eruptions, or more regulated and constant emanations from the many vomitories which now traverse the ancient volcanic areas ;—it would appear obvious that the several detached volcanic assemblages in different parallels, having some given linear direction or range, would properly pertain to remote local phases of ancient submarine volcanic activity, and be remotely separated in age or time. The abundantly-varied mineral components of such several assemblages, may therefore, I take it, be with more propriety termed, generically, *thermogenous products*, rather than “ Plutonic, pyrogenous, or metamorphic rocks ;” the two former terms being commonly applied to the granites, porphyries, and greenstones, and the latter (which is incalculably less capable of being sustained, though propounded by the great Dr Hutton) to their congenerous, cognate, and universally-associated slates and schists. This is done under the notion that they all pertain to one epoch, and are the results of some imaginary phases of change which our planet has undergone, in some process of condensation from a gaseous and fluid to an incrustated condition. Or it may be supposed, that by some alchemical transmutation, sandstones, limestones, and argillaceous rocks have been mysteriously converted into fossiliferous, carbonaceous, arenaceous, and crystalline slates.

As a sequel, therefore, to the former Notices which I have had the gratification to offer to the Geological Society of Cornwall, I wish briefly to state, that for some years past I have satisfied myself that the old red sandstone of the British Isles has been subjected to three protracted phases of volcanic interference.

The first, and most ancient of these systems, is seen in Scotland, where the granite, gneiss, and slate axis of the Grampians, has been protruded through the older red, or the “ primary red sandstone” of Mr MacCulloch. This, after a series of intermittences, appears to have enfeebled down at about the close of the Cambrian system, and ultimately to have expired in the Silurian. The second system of protracted interfe-

rence would be that of Lundy Island, Exmoor, and the Quantocks, in West Somerset and North Devon, which is there superinduced above the Silurian or old red, and where that old red or Silurian incontrovertibly supports it. The third system would be the Ocrynian, which appears to have finally superseded the old red sandstone altogether. The comparatively thin red and grey sandstone band, which extends from Torquay, by Plymouth Sound, to the southwest of Padstow, and of which, interpolated beds are conveyed into the uppermost terms of the killas, precisely the same as the older red is conveyed through the Cambrian, may have been derived from the same ancient sources which supplied the incalculably more abundant materials of the former.

I believe I am fortified in this view, by an adequate, if not by a maximum, per-centage of organic remains, which characterize the great divisions.

The countless and varied remains of fish which have been found in Scotland, appear at present, nearly one and all, to be peculiar to the older red of the first system. Other fossils which have recently been discovered in Peeblesshire and Gallowayshire, have been determined by Mr Salter to be lower Silurian species. The whole of the older rocks of Scotland, which pertain to the first system, I propose therefore to annex to the Cambrian system. The old red of Herefordshire, Monmouthshire, the Mendips, and Exmoor, is so essentially Silurian, that it can with no propriety be separated from that system, as my fossils and the successions will shew. The Ocrynian system will commence where the old red or Silurian ends, and the mixed character of its fauna and its flora, consisting of Silurian, Ocrynian, and mountain-limestone, will constitute the links, and supply the enormous void which subsists elsewhere between the Silurian or old red and the carboniferous strata.

It is proper I should here add, that the alarming and untoward little *Orthides* of either Gorran, or elsewhere in Devon or Cornwall, never must be taken alone or apart from their inseparable associates. Culled and garbled extracts and isolated sentences without their context, whether selected from the Cornish tables, or other leaves of the great stone

book of Nature, will never enable us to attain the truth or a right conclusion. True it is, that the Silurian *Orthides* of Gorran and elsewhere, in their expressive silence, proclaim the hypotheses of "azoic and protozoic formations and strata identified" in danger, as loudly as the Scottish fish and fossils; while the Devonian *Trilobites* in the same hand-specimens of Mr Peach, and the long array of witnesses in my possession from the same range of beds, very sadly depreciate and damage a case which it is attempted to sustain on the evidence of those few *Orthides* alone.

According to my views, therefore, from the north of Scotland to the south of Devon and Cornwall, we have an extended and continuous series of detrital and volcanic-sedimentary and crystalline deposits, if we strip off the mountain-limestone imposition, which is demonstrably no part of such continuous series; the geographical progression being in truth dependent on, and coincident with, the uninterrupted geological successions. The older red of Scotland never can be separated or detached from its associated volcanic products, as may be seen from the Lammermuir hills to the Mull of Galloway, and in Cumberland and the Isle of Man; and these are confessedly as subordinate to the Silurian, as I am prepared to prove the Silurian or old red is inferior to the Ocrynian.—*Annual Report for 1848, of Royal Geological Society of Cornwall.*

Abstract of Meteorological Observations for 1848, made at Appleyarth, Dumfriesshire. By Rev. Wm. DUNBAR, D.D.
 Long. 8° 12' W., Lat. 55° 18' N. Height above the Sea, 180 feet; Distance from the Sea, 10 miles. Rain-Gauge 5 feet from the Ground.
 The Observations made at 9 A.M. and 9 P.M.

BAROMETER.										
1848.	Atmospheric Pressure, Morning.	Atmospheric Pressure, Evening.	Mean of Morning and Evening.	Reduced to 32° Fahr., and corrected to sea-level.	Mean Daily Range.	Mean Nightly Range.	Mean Range in 24 hours.	MONTHLY EXTREMES.		
MONTHS.								Highest.	Lowest.	Greatest Range in 24 hours.
January	29.77	29.76	29.77	29.95	0.132	0.138	0.270	30.40	29.10	0.60
February	29.35	29.34	29.34	29.46	0.175	0.166	0.341	30.24	28.55	0.95
March	29.41	29.44	29.43	29.36	0.142	0.150	0.292	30.03	28.40	0.65
April	29.62	29.61	29.61	29.75	0.091	0.084	0.175	30.00	29.13	0.40
May	29.94	29.91	29.93	30.02	0.083	0.080	0.173	30.28	29.18	0.75
June	29.61	29.61	29.61	29.70	0.074	0.089	0.163	30.10	29.16	0.62
July	29.77	29.77	29.77	29.86	0.093	0.101	0.194	30.39	29.68	0.55
August	29.45	29.37	29.51	29.61	0.086	0.104	0.199	30.05	29.19	0.55
September	29.64	29.65	29.65	29.74	0.096	0.081	0.177	30.25	29.14	0.53
October	29.64	29.67	29.65	29.77	0.096	0.080	0.176	30.22	29.06	0.53
November	29.69	29.68	29.69	29.84	0.106	0.080	0.286	30.46	28.87	0.61
December	29.64	29.64	29.64	29.79	0.148	0.117	0.265	30.35	28.68	0.58
Means	29.66	29.63	29.60	29.81	0.110	0.111	0.211			
1847	29.75	29.74	29.75	29.86	0.097	0.094	0.191			
THERMOMETER.										
MONTHS.	Mean of Greatest Heat.	Mean of Greatest Cold.	Mean Temp. of Morning.	Mean Temp. of Evening.	Mean of Extremes.	Mean of Morning and Evening.	Mean of Both.	Mean Range in 24 hours.	Highest.	Lowest.
January	38.7	29.9	32.7	33.9	34.3	33.03	33.8	9.2	51.5	11.0
February	45.6	33.5	38.8	40.6	40.5	39.07	40.1	9.2	52.0	9.5
March	47.9	33.9	40.5	40.8	41.9	40.66	41.2	12.3	53.0	9.5
April	50.7	35.2	44.0	42.1	43.4	43.03	43.2	14.5	53.0	28.0
May	64.3	44.5	56.4	54.7	55.5	55.05	55.9	19.8	73.5	31.5
June	62.5	48.4	56.5	55.5	56.0	56.00	56.7	10.2	73.5	38.0
July	61.3	49.5	57.5	57.7	55.4	57.06	56.5	14.7	76.0	38.0
August	61.0	46.0	54.1	53.7	53.5	53.03	53.7	14.9	67.0	38.0
September	60.2	46.7	53.0	52.7	52.4	52.08	53.1	13.3	68.5	35.0
October	50.5	42.5	47.0	46.1	46.5	46.05	46.5	10.5	64.0	29.0
November	45.7	35.1	38.1	40.5	40.4	39.03	39.8	10.5	59.0	22.0
December	44.0	30.3	38.9	40.1	40.1	39.05	39.8	8.1	54.0	23.5
Means	52.7	40.5	46.5	45.5	46.4	46.14	46.4	12.8		

Dr DUNBAR's Meteorological Observations for 1848—(Continued).

WINDS—THEIR DIRECTION AND FORCE, AND WEATHER, IN THE NUMBER OF DAYS IN WHICH EACH PREVAILED.

MONTHS.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.	Mode- rate.	Brisk.	Strong Breeze.	Stormy.	Sun Shone out.	Rain fell.	Snow and Hail.	Frost.	Thun- der.	Rain in Inches.
January.....	1	9	5	8	1	4	1	2	12½	4½	5	9	..	24	9	5	23	..	53½
February.....	2	2	2	1	2	14	2½	2½	4	6½	7½	7	4	17	21	4	6	1	563
March.....	2	2	1	1	2	7	2	5	6	13½	7½	4	..	28	14	5	7	..	1410
April.....	2½	2½	1½	1	2	4	2	5	4	10	6	12½	..	30	16	5	10	1	127
May.....	..	2½	1	4½	7	5	5	3	13	5	9	4	..	30	10	..	1	2	148
June.....	..	6	1	4½	4	7	2	..	13	5	4	13	..	28	22	2	..	6	610
July.....	..	4	1	1	3	13½	8	3½	8	8	8	9	..	28	17	..	..	3	497
August.....	..	4	3	1½	2½	6	9	4½	11	7	5	6	2	29	21	1	..	4	650
September.....	..	7½	3	1	3½	6	6	3	7	7	7	10	..	25	20	..	..	1	650
October.....	2	7	3	5	..	9	1	5	4	9	4	10	1	21	20	2	12	..	273
November.....	3	2	2	1	..	4½	9½	8	4	10	4	11	1	21	13	5	14	..	273
December.....	..	1	8	5	6	5½	3½	2	8	6	3	11	3	23	15	5	14	Fog. 3	369
Total.....	10½	56	32	40	35½	92	53½	44	87½	89	72	105½	11	311	184	29	77	19	4251
1847.....	10	52	47	36½	28½	90	58½	40½	107½	93½	71½	77½	13	307	160	26	73	15	2750

REMARKS.

The maximum of *Atmospherical Pressure* was on the 12th of November, when the Mercury stood at 30°·400. The minimum on the 17th of February, 29°·340. Range, 2·120 inches.

The maximum *Temperature* was on the 13th of July, viz., 76°; in 1847 it was 78°·5. Minimum, 1st of February, 9°·5. The mean of extremes, and the mean of morning and evening, the same. The mean *temperature* of the year was 46°·4, lower by one degree than that of 1847, but one-tenth higher than the mean *temperature* of 25 years. The summer in this locality was remarkable for the great fall of rain and high winds.

The quantity of *Rain*, 15 inches more than in 1847; and 8 inches higher than the mean of 20 years. In June, July, and August there fell nearly 16 inches.

Frost prevailed for 77 days, chiefly in January, November, and December; but never to any great intensity.

Snow fell on two days, only to the depth of an inch.

The *Winds* frequently—more so than usual—very violent.

Notice of Plants which have recently flowered in the Royal Botanic Garden. By J. H. BALFOUR, M.D., F.L.S., Professor of Botany in the University of Edinburgh. Communicated by the Author.

STIFFTIA CHRYSANTHA, *Mikan.* Delect. Brasil. I. tab. i. Nat. Ord. Compositæ. Sub-Ord. Mutisiaceæ. — Syngenesia æqualis.

GENERIC CHARACTER.— *Capitulum* homogamum, discoideum, multi-et æquali-florum. *Involucrum* turbinatum, arcte imbricatum; squamæ floribus multo breviores, coriaceæ, multinerves, obtusæ, interiores lineares. *Receptaculum* planiusculum, nudum, alveolatum. *Corolla* subcoriacea, glabra, regularis, limbi quinquefidi laciniis extus circinato-revolutis. *Staminum* filamenta lævia; antheræ exsertæ, longe-caudatæ. *Stylus* cylindricus, glaber, bifidus, ramis brevibus æqualibus acutis. *Achænium* glabrum elongatum brevissime rostratum. *Pappus* multiserialis, paleaceus, longus, paleis linearibus, inæqualibus, serratis. — *Arbores et Frutices Brasilienses glabræ*; ramis *teretibus*; foliis *alternis, petiolatis oblongis acuminatis*; capitulis *terminalibus, pedunculis squamigeris*. DC. et Endlicher.

SPECIFIC CHARACTER.—Foliis lanceolatis acuminatis, capitulis solitariis, floribus capituli indefinitis.

Augusta grandiflora, *Leand.* Akad. Münch. Phil. vii., p. 235. *Plazea brasiliensis*, *Spreng.* The plant is found in Brazil in the vicinity of Rio Janeiro and Bahia.

The specimen in the Edinburgh Botanic Garden is rather more than 6 feet high. Its woody stem is $4\frac{1}{2}$ inches in circumference at the root, and its bark is rough. The primary branches come off in a somewhat dichotomous manner. *Leaves* lanceolate, acuminate, alternate, shortly petiolate, entire, smooth and shining, having a mid-rib, which is slightly prominent both on the under and on the upper surface; venation reticulated, primary veins ending in a curved vein within the margin; petiole slightly grooved on its upper surface, articulated with the stem. *Capitula* solitary, terminal on the young branches, homogamous and discoid, containing about 25 flowers. *Peduncles* short, thickened upward with small scales. *Involucre* turbinated, herbaceous, somewhat coriaceous, its scales 30–40, in several imbricated rows, arranged alternately in a spiral cycle. *Scales* closely applied in the young state, spreading after the flowers fall, green in the middle, paler towards the margin, which is fringed with short hairs; outer scales short,

ovate, often tipped with black: intermediate ones longer and less ovate; those of the inner rows becoming gradually more elongated; the innermost (next the flowers) being pale, oblong-linear, and about 1 inch in length. *Receptacle* lactescent, nearly flat, naked, marked with hexagonal spaces, in the centre of each of which is a depression for a flower. *Pappus*, in æstivation, closely applied round the conical bud, its hairs, when expanded, about $1\frac{1}{2}$ inch long, reaching nearly to the tip of the corolla, arranged in several rows; these hairs are unequal in length, are beautifully serrated, of a pale orange colour, persistent, and spread much when the corolla falls. *Corolla* smooth, regular, tubular, and somewhat funnel-shaped, $1\frac{1}{2}$ inch long, of a pale orange colour below, and becoming darker above, divided at the apex into five revolute and circinate narrow segments of a dark orange colour, about $\frac{1}{2}$ an inch long when unrolled. *Filaments* smooth, coloured, inserted into the upper part of the corolla between the segments, arching over the mouth of the corolla to join the anthers at the upper part of their lower third. *Anthers* about an inch long, two-lobed, exserted, bifid at the apex, with a long bipartite process below; pollen three-lobed. *Style* cylindrical, extending nearly 1 inch beyond the corolla, and about $\frac{1}{2}$ of an inch beyond the antherine tube, undulated at its lower part. *Stigma* bifid, hairy on the inner side of the lobes, which close after the application of the pollen. *Achæmium* (*Cypsela*) in the young state triangular, $\frac{3}{4}$ of an inch long, of a green colour, with a short yellowish beak at the summit.

The plant appears to have been sent to the Edinburgh Garden some years ago from Kew, where it is also flowering this season. The capitula are very showy, and the plant is a desirable one for a stove. It has been flowering since the beginning of February, and at one time there were six large capitula expanded. After the flower falls, the spreading pappus presents a remarkable appearance on the tree.

QUASSIA AMARA, Lin. fil. Suppl. 235.—Nat. Ord. Simarubaceæ.—Decandria Monogynia.

GENERIC CHARACTER.—*Flores* hermaphroditi. *Calyx* brevis quinquepartitus. *Corollæ* petala quinque, hypogyna, calyce multo longiora, æstivatione contortim-imbricata, sub anthesi in tubum convinentia. *Stamina* 10, hypogyna, petalis longiora; filamenta squamulæ brevis apice pilosæ dorso inserta, filiformia, flexuosa; antheræ introrsæ, biloculares, ovato-oblongæ, dorso supra basim insertæ, longitudinaliter dehiscentes. *Ovaria* 5, gynophori brevis lati centro insidentia, libera, unilocularia; ovulo unico, angulo

centrali infra apicem appenso, anatropo; styli ovariis continui, basi discreti, mox in unicum staminibus longiorem, contortum coaliti; stigma quinque-sulcum. *Drupæ* 5, vel abortu pauciores, sessiles, patientiusculæ, uniloculares, monospermæ. *Semina* inversa, testa membranacea. *Embryonis* exalbuminosi, orthotropi cotyledones carnosæ; radícula brevissima, inter cotyledones retracta, supera.—Arbor *Guianensis* nunc in *Antilles* advecta; foliis alternis, impari-pinnatis, petiolis alatis, foliolis oppositis, integerrimis, nitidis; floribus majusculis, coccineis, in racemos terminales, simplices vel ramosos dispositis, pedicellis basi bracteatis, sub apice articulatis, ad articulum bibracteolatis. Endlicher.

SPECIFIC CHARACTER.—Arbor glabra, foliis impari-pinnatis, petiolis alatis, racemis terminalibus, floribus magnis rubicundis.

This plant is the original source of Quassia-wood, which was first made known by Linnæus about the middle of last century. It was named by him after a negro called Quassi, who used the wood in Surinam as a febrifuge. It is a tall shrub, attaining a height of 15 feet, found in Surinam, Guiana, and Columbia. The Quassia of the shops is the produce of a large forest tree, *Quassia excelsa* of Linnæus, *Simaruba excelsa*, DC, and *Picræna excelsa*, Lindley. The specimen of Quassia amara in the Edinburgh Botanic Garden was sent by Professor Syme, who reared it at Milbank, from seeds which had been transmitted to Dr Christison in a germinating condition. It is a vigorous plant 6 feet high, branching chiefly at the upper part. The stem is 3 inches in circumference at the base. Bark of a light-gray colour, somewhat wrinkled; in the young branches reddish. Leaves varying much in form. Those at the lower part of the stem are simple, elliptical, and acuminate; while those at the upper part are impari-pinnate, with more or less elliptical, pointed pinnæ. Between these two extremes there are all gradations; some have a slight contraction about the lower third of the lamina; others have a distinct winged petiole, separated from the lamina by an articulation; others have a single lateral pinna developed, others two, and others four. The complete leaf has two pairs of lateral pinnæ (bijugate), and an odd leaflet at the end, the petiole being winged throughout, and distinct contractions and articulations occurring at the points where the pinnæ are given off. The plant, during the first year of its growth, produced only simple undivided leaves, in which the lamina and petiole were continuous. The young leaves now produced, all exhibit the impari-pinnate character. In the simple leaves, the lamina is large and the petiole short; the largest are 9–10 inches long, and about 3½ inches broad. They have a

reddish midrib, with the primary veins ending in curved veins within the margin. The separation between the winged petiole and blade is indicated first by a tendency to contraction; the lamina being about $6\frac{1}{2}$ inches long, and the petiole $3\frac{1}{2}$ inches. There is at length a complete separation, and a swelling of a reddish colour formed, and from this, one or two lateral leaflets proceed. Another swelling of a similar nature occurs ultimately about 1 inch nearer the apex of the leaf, and there also one or two leaflets are developed. What was the lamina in the simple leaf, may be said to be the odd leaflet in the pinnate leaves, which is now much smaller than it was in its simple state.

Both simple and compound leaves are alternate, smooth, shining, and are attached to the stem by a large reddish swelling (pulvinus). The petiole in the complete leaf consists of three winged pieces, with distinct contractions, the wings becoming broader upwards, and attaining the breadth of $\frac{1}{2}$ an inch. The flowers (10 or 12 in number), are produced in terminal bracteated racemes, and are of a scarlet colour. In our plant, unfortunately, they have all fallen off in the state of bud, without becoming expanded. *Calyx* short, with 5 divisions of a reddish-brown colour. *Petals* 5, ovate-lanceolate, of a fine red colour, much larger than the calyx; contortimbricate in æstivation. *Stamens* enclosed within the petals in the state of bud. It is hoped that, ere long, the plant may produce perfect flowers, so as to give an opportunity of making the description complete.

Dr Christison, in a letter to me, has sent the following statement as to the source whence the specimen in the Botanic Garden was derived:—

“ We are indebted for your *Quassia* plants to Dr Hartle of Trinidad. In 1844 he sent me, in a small box, twigs, leaves, flowers, fruit, and one or two sections of branches of *Quassia amara* from his garden, that I might compare the plant with its descriptions. The specimens having been shut up in the fresh state, and long detained in the custom-house at Greenock, the branches, leaves, and flowers, were all rotted before reaching me; and under favour of this process, the seeds were germinating. One of them had a shoot above an inch in length.

“ I immediately divided these seeds between Dr Graham, and Professor Syme; and both Mr Macnab, and Mr Reid, gardener to Mr Syme, succeeded in raising several of them. Your specimen, which has made an effort to flower this season, is one of those raised by Mr Reid. It grew very slowly during the first and second summers, and shewed only simple leaves destitute of any tendency to pinnation, or winged petioles. But as I had no doubt whatever of the seed, I felt assured that in time the true pinnated and winged leaves would make their appearance. This accordingly took place in the third year, when the plant

sprung forth with great speed and luxuriance in Mr Syme's pine-house. Its subsequent history you know.

"I have long been surprised that so beautiful a shrub is not cultivated by horticulturists. I have never seen it in any stove in this country, and have never heard of its being grown before, though I have often inquired about it. Among other qualifications for a hothouse plant, it does not attain a great altitude. There have been doubts on that head in consequence of *Quassia amara*, the original source of Quassia-wood, having been confounded with the giant *Picræna excelsa*, a great forest tree, which has long supplied the only Quassia-wood to be met with in European commerce. No one can entertain any doubt, however, who has attended with moderate care to the subject. Nevertheless, I may mention, that on asking information on this point from Dr Hartle, he was good enough to cut down one of the tallest plants in Trinidad, which grew in his own garden, and sent me trunk, branches, leaves, flowers, fruit, every thing in short but the root. The trunk is 9 feet long, the branches 6 feet, so that the usual description, which represents it to be 12 feet, and at most 15 feet high, seems exact."

Wernerian Natural History Society.

At a late meeting of this Society, Professor T. S. Traill, Vice-President, in the Chair—Assistant-Commissary-General Robert Neill gave an account of the habits of the *Keelong* or *Chelodina longicollis* of New Holland; and exhibited a living specimen, brought by him from King George's Sound, and probably the only living one ever seen in Europe. It is an aquatic tortoise, inhabiting fresh-water lakes and marshes. From the nose to the tail it measures 1 foot 4 inches, the neck and head occupying about 6 inches. When it raises its head above the water, and its large oval shell is immersed, it so greatly resembles a poisonous black snake which inhabits the same localities, that even the natives are sometimes deceived and frightened. It feeds upon the spawn of frogs, young tadpoles, and *chulgies*, or small crayfish, which last are described as very abundant. The natives esteem the Keelong very much as food; and Mr Neill mentioned that he had boiled one, and found it to resemble in flavour a tender fowl. It is not seen during the winter months, from June till August; and Mr Neill thinks that it remains torpid during that season, burying itself in the soft mud under the roots of reeds. About the beginning of February (the Australian midsummer) the Keelong comes on shore during the night, makes a hollow in the sand, and lays from twelve to eighteen eggs, about the size of those of a pigeon, but more oblong. It covers up the eggs, and leaves them to be hatched by the heat of the sun; but the natives, knowing the surface-marks, collect great numbers of them for food; and Mr Neill mentioned that he had tasted them when cooked at a native's fire in the woods, and found them delicate and good. Dur-

ing the journey from King George's Sound to Edinburgh, the Keelong remained five months without food, was only twice dipped in water, and arrived much emaciated and very weak. It is now kept in a hothouse in Dr Neill's garden at Canonmills, and has recovered vigour; its neck and limbs, which were shrivelled, having become full and firm. It is fed every second or third day, and greedily gulps down some bits of raw butcher-meat, placed in its water-trough.

On this occasion, Mr Commissary Neill presented various implements, the work of the natives of Western Australia, forming an interesting addition to the valuable ethnological department of the University Museum.

Several minerals remarkable for their novelty, rarity, or great beauty, were afterwards exhibited. Among these were particularly noticeable specimens of that rare mineral the *Datolite* in greenstone, as found in Salisbury Crags, near to this city, where it was first discovered many years ago by Professor Jameson. As the Professor considered the datolite of Salisbury Crags of contemporaneous formation with the greenstone, he considered that boracic acid, the most characteristic ingredient of the datolite, might prove to be a constituent of some varieties of the greenstone; but we did not learn that the greenstone had been tested for boracic acid. A fine mass of *meteoric iron*, found on the Continent of Europe, was also exhibited. Very fine specimens of *Diopase*, or silicate of copper, were shewn, being the most precious ever seen in Scotland. The same may be said of some *Telluriums*, which were likewise submitted to the inspection of the meeting.

It was announced that four large cases, containing a very valuable collection of quadrupeds, birds, &c., collected by Mr William Jameson, H.E.I.C. Service, in India, had reached the College, and would soon be prepared, and deposited in the Museum. Also, that a beautiful series of specimens of birds, brought from the west coast of Africa by Staff-Surgeon Dr Gordon, of this city, was in the course of preparation. The receipt of a collection of copper ores, from the famous Australian copper-mine of Burra-Burra, presented by Assistant-Commissary Neill, was also acknowledged.

The late W. H. Townsend, Esq.—A notice of the death of the accomplished Mr W. H. Townsend, artist to the Society, was communicated to the meeting by Professor Jameson. The loss of the remarkable and varied talents of that gentleman, so universally acknowledged, will be long and deeply felt by the Wernerian Natural History Society. Mr Townsend excelled in delineating objects of natural history, of comparative anatomy, and morbid anatomy; and his drawings of geological subjects and of the physiognomy of countries, were excellent. It was remarked of Mr Townsend, that he had left in Scotland few equalling him in these important departments of art.

SCIENTIFIC INTELLIGENCE.

GEOLOGY.

1. *Contributions to the Flora of the Brown Coal-formation.* By Prof. Göppert.—In the year 1839, I examined some of the bituminous wood found in the brown coal-formation, in various districts of Northern Germany,* and at that time described two species (*Pinites protolaria* and *Taxites Ayckii*), which, from the width of their distribution, seemed to me peculiarly deserving of attention. More recently, in the work published conjointly with Dr Berendt in Danzig, on the vegetable remains found in amber, I collected a flora, comprising fifty-four species, which, in regard to the genera, could not be distinguished from that of the brown coal; although no brown coal-beds, containing amber in its natural position, have yet been certainly pointed out. The amber, which I formerly thought I had discovered in the brown coal at Muskau is nothing more than Retinasphalt. I now possess a small stem covered with the bark, on which the resinous exudation appears in drops, and many other fossil coniferæ, among them even taxineæ, shew the same appearance, but none of them, so far as I know, such an abundance of resin as the small stems and the fragments of wood in my collection which produced the amber. These I have figured and described in the work mentioned above, and they have been seen by a great number both of German and foreign naturalists. At present, they must be regarded as the only remains which give us any certain knowledge of the existence of at least one tree producing amber, although I have no doubt that there were several. Dr Thomas, to whom I am indebted for many interesting contributions to my inquiries, having chemically examined several remains of wood from the brown coal-deposits of the Samland, and found succinic acid in them, considers that these trees must also be added to those producing amber, and that these deposits generally must be regarded as the place in which this substance originates. I would, however, remark, that this fact alone cannot be considered as sufficient proof, since succinic acid occurs as a product of oxidation of many kinds of wax or fats, in many deposits of brown coal, and even in the resin of still existing coniferæ and several other plants, as in wormwood and lettuce. The actual occurrence of amber in the wood or the layers of bark, can alone prove decisive, and justify us in regarding a fossil as belonging to a tree producing amber. But even were the original bed containing the amber tree actually discovered on the coast of Prussia, and that it may be so I have the less reason to doubt, from having never visited the place myself; still the numerous facts collected by

* See a paper "On the Bituminous and Petrified Wood recently discovered in the basaltic tufa of the high Seelbachkopfe near Siegen, with Remarks on the Brown Coal-formation generally," in Karsten and V. Dechen's Archiv, vol. xiv., p. 182, &c.

my respected coadjutor, proving the wide drifting of the amber by floods in the districts round the Baltic, lose nothing of their value ; and I can now only confirm their truth, from many observations which I have either made personally in Silesia and the Lausitz, or obtained from others.* In not one of the many brown coal-beds opened in our province has amber ever occurred, but always in the undoubted drift deposits (*in rien aufgeschwemmtem Lande*) above them, generally very near the surface, in sand or loam pits with many boulders, and, as very lately above the brown coal-bed at Schwiebus, with fragments of friable wood, rounded on all the corners like drift-wood, such as I never saw in our brown coal-deposits. The number of localities in both provinces known to me at present, amounts to *ninety*. I confine myself in these, as in all similar cases, entirely to observations on which prejudice can have no influence, as I do not consider myself qualified to decide on geognostic and geological questions ; but I entreat geologists not to neglect such observations, especially at present, when there seems a disposition unconditionally to recognise our brown coal-deposits as the native place of the amber. I have only interfered with this question, so far as, from the existing materials, considered in a purely botanical point of view, I have endeavoured to shew, what hitherto had not been done, that there existed at least one amber-bearing tree ; and, at the same time, from the other inclosed vegetable remains, to construct a picture of the co-existing flora. A solution of the still unsettled problem of the original repository of the amber, I leave to geologists ; almost the whole of the specimens of the amber tree in my collection mentioned above shew distinct traces of having been drifted.

Continually occupied with the examination of the bituminous wood found in the brown coal-deposits of Northern Germany and the Rhine, I shall annex to these observations a few of the results obtained.

(1.) The predominance of coniferæ seems very remarkable. Among 300 specimens of bituminous wood collected in the Silesian brown coal-deposits alone, only a very few other kinds of dicotyledonous wood occur. This seems the more remarkable, since, in many places, leaves of dicotyledonous trees, with deciduous foliage, have been found in the clays of the brown coal-formation, and yet in the coal-beds the trees on which we may suppose them to have grown are wanting. This might be regarded as indicating a formation from drift-wood ; but the following considerations are opposed to this view.

In the brown coal-beds at Blumenthal, near Neisse, wood of deciduous trees occurs, along with twigs and fruits of a *Taxus* and *Cupressinea* ; amongst the trees only *Taxus* and *Cupressinea*, with no trace of any other kind of dicotyledonous tree. This seems an important fact, as perhaps leading to an explanation of this remarkable phenomenon. I believe that during the process of maceration

* *Julius Müller in der Allgem. Naturalist. Zeit. von Sachse, vol. i., 2 Heft.*

and decomposition, to which the vegetation of the brown coal-forests was subjected before it was buried between layers of earth, and protected from atmospheric influences, the deciduous-leaved trees lost their organic connection sooner than the highly resinous wood of the coniferæ, and hence fell to pieces, whilst the latter were, for the most part, preserved,—a view, so far as I know, in harmony with the result of experience on the duration of these kinds of wood in similar circumstances. I throw out this, however, only as a conjecture, which may perhaps be subsequently confirmed by an examination of different brown coal-deposits.

(2.) The number of species is, on the whole, very small, in comparison with the enormous mass of brown coal they have contributed to form, from which we may conclude that the coniferæ of the ancient world had a similar gregarious mode of growth with those that now flourish on the earth. To prove this in certain beds, even for single species, I collect as many specimens of different trunks or fragments of bituminous wood as are to be found, and then examine them. From this, the predominance of certain species at once appears; and though it may be justly remarked that several fragments of one and the same tree may often occur, still frequent repetition of this somewhat laborious process at last enables us to obtain a result approaching nearly to certainty.

(3.) The fossil species are remarkably distinct from those of the present coniferous flora of Northern Germany; few resemble our *Pinus abies* and *Picea*, and I have hitherto only found a single species with the structure of *Pinus sylvestris*, or generally of the genus *Pinus*, as limited by Richard and Link; the greater part agree with *Cupressinea*, if we may judge from the smooth bark of the larger stems, the sharply-defined annual rings, the smaller number of cells contained in a medullary ray, although there are exceptions to this rule; while the predominance, even quantitatively, of the form of *Taxus*, of which I can well distinguish at least four species, is remarkable. Among them are species of which the wood, formed of cells with thick walls, is denser and more compact than that of the existing *Taxus*, but also one species of uncommon lightness and with large cells, similar to the wood of the North American *Taxus montana*, Nutt., or *Torreya taxifolia*, Arnott. My present, as well as former researches, shew as a whole that a great similarity prevails between the flora of the brown coal and the flora of the temperate zone of the United States of North America. This will appear more decisively when I am able to bring together all the results bearing on this point.

All the species of *Taxus* observed in the brown coal differ remarkably from those now existing in the three or four fold striation of the sides of the cells running at acute angles; whereas in the latter, a single fibre forms an almost horizontal spiral. In many brown coal-deposits in Silesia, as well as in Prussian Saxony (Nietleben, near Halle Wörschen, Gramschütz, Rosslach, near Weissenfels, Tenditz,

Tollwitz, near Dürenberg, Voigstedt, near Artern), species of *Taxus* seem to predominate, even quantitatively, and among them the *Taxites Ayckii*, formerly described, has an uncommonly wide distribution, not only in the localities now named, but also occurs in the Rhenish brown coal-deposits, in Hessenbrück, near Laubach, in the Wetterau, in Silesia, the Lausitz, at Redlau, near Danzig, in the Samland in Prussia, and Ostrolenka in Poland. Further researches will undoubtedly shew similar results in relation to other species, as for example the *Pinites protolarix*.

(4.) Narrow annual rings, consequently a highly-compressed growth, such as in existing coniferæ, is only found, according to Martins, in high northern latitudes, and, according to my own observations formerly published, on high mountains, is constantly found prevailing in the bituminous trees, and imparts to some of the wood an uncommon density and weight, similar to that of Guaiac wood. In many species, I have counted 15 to 20 annual rings in the breadth of a line; of course in round stems, as in those pressed flat, the influence of the compression must also be taken into account, though in other respects its influence, as for instance on the walls of cells, is less than might be imagined. A stem of a *Pinites protolarix*, from the brown coal-pits near Laasan, with a diameter of 12 inches in breadth and 16 inches in length, shewed, in this narrow circumference, not fewer than 700 annual rings. Yet in the ancient, as in the present world, there was a great diversity in the rate of growth even of the same species, for in another nearly cylindrical stem of this tree, 16 inches in diameter, only 400 annual rings could be distinguished.

(5.) I have repeatedly observed on trunks and branches the broken-off twigs and branches grown over by new layers of wood, and to my great joy, in the brown coal-pit of Francisca, at Popelwitz, near Nimptsch in Silesia, a stump of a conifera perfectly shut in by the more recent layers, which might have served right well for a *Krater*, or drinking cup, for which, as Theophrastus tells us, the ancient Thracians used these stumps of the pine. As the same laws of vegetation prevailed in the ancient and in the existing creation, there is nothing singular in this observation; yet still it seemed to deserve a passing notice.—(*Arbeiten der Schlesischen Gesellschaft*, 1847, p. 74; and *Quarterly Journal of the Geological Society*, vol. v., p. 4.)

2. *On the Ampo, or Tanah ampo, an earthy substance eaten at Samarang and in Java, its geological position, and the organisms it contains.*—This earthy or clayey substance, already noticed in the year 1792 by Labillardier, occurs, according to M. Mohnike, in many points at a height of 4000 feet, among the secondary formations which extend from north to south in the island of Java. It is in general solid, plastic; it is kneaded and formed into small rolls, which are dried over a charcoal fire. These rolls are eaten with great avidity and as a delicacy. Ehrenberg, on examining this earthy substance, discovered in it from three to four polygastries, and

thirteen phytolithaires, a circumstance which seemed to indicate that the earth or clay was a fresh-water tertiary deposit.

3. *The Geognostical Position of the Nummulitic Formation.*—M. L. Rutimayer, in his researches on the nummulitic formation, arranges it in the tertiary class; and also the Alpine macigno, or Hettrurian formation, which in Switzerland lies over it. He arranges in the same formation the whole series of the sandstone of Gurnigel, of which the sandstone of Ralligen, and of Taviglianaz are but a modification.

4. *Marks of Glacial Action in Ireland.*—In a late visit to Ireland, I have observed undoubted evidence of glacial action in the polishing and scratching of rocks in several parts, as near Limerick, on the summit of the cliffs at Kilkee (on the coast of Clare), and at Howth near Dublin. These points appear to me all too remote from any mountain or valley in which a *glacier* could have originated, for that to have been the cause of their appearances; and, taken in combination with similar instances which I have found in several parts of the east coast of Scotland and in Wales (likewise remote from any spot adapted for a glacier), I am inclined to the opinion that they have resulted from a great part of these islands having at one period been entirely covered with ice, like some of the Arctic regions at the present day. It has also often occurred to me, that the action of a mass of ice in motion, is to be observed in the broken edges of some of the softer slaty or shaley rocks, especially where the beds are nearly vertical, and their upper termination appears to have been broken or pushed aside, and, generally, in one direction, by the passage of a heavy mass over it, when, from the softness of the rock, it could not bear such a shock without fracture. This appearance extends sometimes for several feet between the surface-soil and the more solid rock, several good examples of which may be seen on the cliffs extending from Arbroath towards the Red Head, Forfarshire; on the summit of this promontory, the rock, being much harder, has not been shattered, but shews marks of polishing and scratching. May not the enormous triturating power of such a coating of ice, as well as that of glaciers and icebergs, have formed, from the destruction of the rocks with which they have come in contact, much of the deep subsoils (clay, sand, &c.) with which great part of these islands abound?—*W. C. Trevelyan* (*Nettlecombe*, 16th February 1849).

ZOOLOGY.

5. *Fertile Mules.*—M. Wagner announced to the Academy of Sciences of France that he has received from M. de Nanzio, Director of the Royal Veterinary School of Naples, a memoir of great physiological interest, which he laid before the Society, accompanied with the following observations. The memoir is entitled, *Intorno al concepimento et alba figliatura de una Mula*, 18 pages, 4to.

It is well known, says M. Wagner, that the rearing of the mule

is connected with that of the horse and the domestic animals from the earliest antiquity, and that from the most ancient times the mule has been employed, in the south of Europe, and in the present day, perhaps, even more generally than ever, in drawing or carrying burdens. It is a fact generally known, that mules, male and female, are steril, and that we cannot succeed, by copulation, either between themselves or with the original animals,—the horse and ass,—in rendering them fruitful. In all countries where mules are reared, the most ignorant individual is aware that these hybrids are infertile, and he considers the facts of fecundation either as fables, or as wonders which, like extraordinary celestial phenomena, are omens of evil. This opinion is general throughout Italy and Sicily. Cases of fecundation are, in fact, very rare, the greater part doubtful, and still more rarely well established. In Germany, where the mule has been reared only in very restricted localities, no fact of this kind known to me has hitherto occurred. In southern Europe, many instances are recorded. Aristotle, Herodotus, Varro, and other ancient writers, have mentioned some instances, and others have been related by authors up to the present time. M. A. Wagner of Munich has recently made a critical examination of these, in the sixth volume of the new edition of Schreber's History of Mammifera. M. de Nanzio reports some cases of this nature from the Italian writers of the sixteenth century, which had escaped the notice of M. A. Wagner, and they always regard them as dismal presages, signals of war, pestilence, and famine. In extra-European countries, experience has proved only the fact of sterility; and the theoretical opinion that the fecundation of these hybrids ought to be more frequent in warm countries, is by no means verified in regard to South America, at least if we may rely on the testimony of Azara, an attentive and conscientious observer.

In the memoir in question, it is unfortunately not mentioned whether the mule was the produce of a male or female ass. In Italy, it is the custom to call both by the name of *Mula*. It is known, however, that they distinguish the mule, *Equus mulus*, in Italian *Bardotto*, which is the produce of a male ass and a mare, from *Equus hinnus*, in Italian *Mulo*, which is the produce of a horse and female ass. If we refer to the figure given in the memoir, of the mother and colt, these animals will be found to bear a greater resemblance to a horse than an ass. On the other hand, MM. Panizza and Capelli, in the report on this subject which they made to the Italian congress at Naples, in 1845, express doubts with regard to the mother, as affording uncertain indications of hybridity in its character. Yet I am disposed to believe, with these two authors, and after inspecting the documents, that there cannot be the least doubt that we have here an authentic example of the fecundity of a hybrid.

The mule in question belonged to a certain Francesco Mastrangelo, of the commune of Anzana, in the province of Capitanato. It was brought forth on the 15th July 1844, a male colt, and caused such

astonishment in the country, that the fact was established by a regular investigation. This mule had been covered by a stallion horse; but while she was with foal, the thing appeared so incredible that she was considered as affected with dropsy, and her master wanted to get quit of her. Eight months after the birth of the colt in question, which, it may be mentioned, thrived well, an attempt was made to cover her again, but without success.

At the conclusion of his memoir, the author gives us the results of a microscopic examination, which he undertook along with M. de Martins, of the sexual organs of another mule. It was found that the primitive ovule, the vesicle of the germ and the blastoderm, as well as the oviduct and uterus, &c., are precisely the same as in the mare and female ass, and that it is impossible to detect any anatomical condition to account for sterility. A beautiful engraving presents all the details of this investigation.

I have made many attempts to produce hybrids among mammifera, as I had formerly done among birds, but hitherto I have not succeeded. The work in question confirms the conclusions I had drawn from the examination of birds, namely, that, in the organs of the sexual parts where the germs are developed, there are fewer differences in female mules, compared with those of the female animals from which they are derived, than in the male organs. Hebenstreet, Bonnet, Gleichen, MM. Prevost and Dumas, have examined the sexual organs of mules, and they have never met with the conditions of a procreative sperm, that is to say, containing complete spermatozoa. I know, moreover, that in the mules of birds, we find only an incomplete production of what are called spermatie animals, and Brugnone is the only writer who, contrary to the preceding experiments, says that he found mobile fillets in the sperm of mules. Some years since, I begged M. Hausmann, of Hanover, since deceased, to undertake new researches on this subject. This philosopher has embodied his observations in an autograph memoir, which unfortunately has not been published, but it appears that a mare which had been several times covered by a mule never became pregnant. The seminal fluid of a male mule in season for the twelfth time, analysed after covering a mare, contained no spermatozoa.

From all the facts hitherto collected, we may, therefore, conclude, that wherever examples are alleged to have occurred of fertile copulations of mules, they always refer to female animals; that the procreative faculty appears absolutely wanting in male hybrids; and that this fecundation, which is excessively rare, cannot take place without the effective production of living and mobile spermatozoa.

6. *The Oil of Herrings*.—M. de Quatrefages has addressed a note to the Academy of Sciences on the extraction of the oil of herrings, and the preparation of *tangrum*, a manure which he considers fitted to form a substitute for guano.

The object of the note is to draw attention to some facts, too little

known, which seem to him calculated to open up a branch of industry long forgotten in France, and to enrich agriculture with an entirely new manure. These facts are derived principally from the unpublished documents which M. Noel de la Moriniere, late General Inspector of Fisheries, had collected for a General History of Fishes among the Ancients and Moderns; but he died after publishing only the first volume. His papers, first submitted to Cuvier, passed into the hands of M. Valenciennes, who communicated them to M. de Quatrefages.

A very simple process is employed to extract the oil of herrings. The fish are boiled in fresh water for five or six hours, and constantly stirred. When the herrings are reduced to a pulp, the mass is allowed to cool; the oil swimming on the surface is then collected, and clarified by filtering, or simply by pouring it several times from one vessel into another, and it is then put in barrels. It thus appears that the expression to *burn herrings*, which is used to express this process, is far from giving an exact idea of it.

The preparation of herring-oil, known in the thirteenth century, and practised in France under Colbert, was carried on on a large scale in Sweden in the last century. At first, only the gills and intestines of the fish, the parts removed before salting, were used; but afterwards the entire herrings were employed as the manufacture became more lucrative. Places for carrying on the process were formed on almost all the rocks along the sea-coast. The burners had thus the means of transporting the fish to their establishments almost without expense, and likewise of easily getting quit of the matter which remained in the bottom of the boilers after the oil was extracted. This residuum, called *tangrum*, was thrown into the sea. M. de Quatrefages proposes to make use of it as a manure.—(*L'Institut*, No. 780, p. 382.)

7. *M. Pouchet on the Digestive and Circulating Organs of Infusory Animals*.—Naturalists are not yet agreed with respect to the degree of organisation which the greater part of the microzoary animals attain. Some deny them interior organs; others, on the contrary, think that they possess a somewhat complex vital apparatus. M. Pouchet is of opinion that the imperfection of our knowledge, relatively to the organisation of these animals, has been owing to this, that, with the exception of the Vorticelli, which are ill fitted for the study of the vital phenomena, the same individual has not been long enough subjected to observation, as they suddenly disappear from the field of the microscope. He has succeeded in making longer and more accurate observations, by placing Microzoa on very fine lawn, and pressing the latter slightly with the compressor. Meshes or intervals were thus obtained from 0.10 to 0.12 of a millimetre, in each of which he could usually retain only one of these animals of a pretty considerable volume. There, without disabling them, one could follow successively the mode of introducing the alimentary substances, the process by which these were divided in the stomachic

vesicles, and, finally, their expulsion in the state of excrements; there, also, one might count the contractions of the vesicles intended for circulation, and determine the intervals by measuring the extent.

The following particulars, says M. Pouchet, are what I have distinctly observed up to the present time; and they are points, I believe, respecting which no serious objections can be afterwards entertained.

1st, In the Infusoria, named Polygastric by M. Ehrenberg, there evidently exist vesicular stomachs more or less numerous.

2d, The number and diameter of these stomachs is fixed in each species that has attained its full development.

3d, In the Vorticelli, from 30 to 40 vesicular stomachs can be counted, from 0.008 to 0.010 of a millimetre in diameter, when they are filled with food. In the Kolpodes, there are always from 20 to 30 vesicular stomachs of 0.010 of a millimetre in diameter when filled.

4th, The gastric vesicles never run into one another when they come in contact. It is easy to perceive that they have distinct walls. The alleged rotation of these stomachs is a curious optical illusion. These organs are fixed in their respective region, and never remove from it but in respect to the elasticity of their tissue.

5th, The aliment does not form a bolus swallowed at once, and producing by chance vacuities in the tissue of the animalcule; on the contrary, it is introduced gradually. It is seen at first to fill partially each of the gastric vesicles, and then to occupy them entirely.

6th, The contractile vesicles of the Microzoa are true circulatory organs, representing the single or multiple heart of the higher animals. It is impossible to regard them as respiratory or genital organs, as some naturalists have done.

7th, These contractile or cardiac vesicles are usually single, and contain a fluid analogous to blood, presenting a texture of a clear fulvous yellow, which renders it easy to distinguish them.

8th, In the Vorticelli, the cardiac vesicle is single, and acquires an enormous volume compared with that of the animalcules. In Vorticelli of 0.080 of a millimetre in diameter in length, it attains to 0.020 of a millimetre in diameter when fully dilated. It appears also that in these Microzoa it has distinct walls, and that it terminates anteriorly in a yellowish conduit. In the Kolpodes, the cardiac vesicle is likewise single, but proportionally smaller; it is 0.015 of a millimetre in diameter in individuals 0.10 of a millimetre in breadth. In the Glauconus, it is only 0.010 of a millimetre in diameter. In the Dileptes, there are two cardiac vesicles which contract successively, one at the posterior extremity of the body, the other towards the centre.

9th, In the Vorticelli, the cardiac vesicle fills very slowly, and empties itself only at long intervals, but suddenly. It contracts

every two or six minutes, according to the temperature or vitality of individuals. In the Klopodes and Glauconus, the movements of this vesicle exactly imitate those of the heart; they are very close upon one another, and the organ dilates and fills instantaneously with sanguineous fluid. The contractions take place every 7 to 10 seconds, at a temperature of 20° C.

M. Pouchet's observations have been made on the following species;—*Vorticella infusiorum*, Duj.; *Klopoda cucullus*, Muld.; *Glaucoma scintillans*, Ehr.; *Dileptas folium*, Duj.—(*L'Institut*, 25th November 1848, p. 349.)

8. *Artificial Fecundation of the Ova of Fishes.* By M. A. de Quatrefages.—The remarkable fecundity of fishes is well known. By the researches of different authors, it has been ascertained that a perch, of medium size, contains 69,216 ova; a pike, of 10 kilogrammes, has afforded 166,400; 167,400 have been counted in a carp weighing a little more than 1 kilogramme, and 621,600 in another individual of the same species which weighed 4½ kilogrammes. Rousseau gives 7,635,200 as the number of ova in a sturgeon, and Leuwenhoeck has reckoned as many as 9,344,000 in a single haddock.

Looking at these figures it is natural to ask, how it happens that the number of fishes is not more considerable. This may, perhaps, be explained by taking into account the circumstances which prevent the development of these myriads of germs. We know that, in the greater number of fishes, there is no copulation. At the time of spawning, it is true, the males and females alike seek for localities suited for the development of their ova; but the latter are deposited, and the fecundating liquid emitted, without any union of the sexes to secure the contact of these two elements. Fecundation is quite accidental, and, consequently, a great number of ova perish without being fecundated. Besides, the spawn of the females is very often devoured at the very moment of deposition, either by voracious fishes, or by the parents themselves. Lastly, the spawn laid near the banks, in rivers and ponds, very often perishes, by being left dry in consequence of the waters retiring from them.

Artificial fecundations would remove all these causes of the destruction of the ova, and the practice to this method presents no difficulty. It is sufficient to place the ripe roe of a certain number of females in some vessel along with a quantity of water sufficient to allow the ova to float freely when the liquid is shaken, then to press out the milk of the male into this vessel. In a few instants, if the ova have reached their term, and the fecundating liquid be sufficiently elaborated, fecundation will be completed; all the ova will be fecundated. We know that fishes, experimented upon in this way, fulfil these conditions, for, by pressing the abdomen slightly from before backwards, we can easily squeeze out the contents of the reproductive organs. The ova once fecundated, ought to be placed in a situation proper for their development, and here precautions are required

which vary with the species on which we operate. The ova of fishes of stagnant waters and fish-ponds require little care; it is sufficient to place them in a spot having a bottom of aquatic plants, where the water is tranquil, and of little depth. They ought, besides, to be protected, in some way, by a kind of net-work, for example, against the attacks of their enemies. The ova of fishes, inhabiting running waters, are a little more difficult to hatch. The following is a very simple process, which has been practised with success since the middle of the last century by a German, Count Golstein, to bring out the young of salmon:—Construct a box with a moveable cover, about 4 metres long, by 30 or 35 centimetres broad, make an opening of 16 or 17 square centimetres at the two extremities, and close them by a close grating. The bottom of this box is covered with sand and very clean gravel, then the apparatus is placed on the margin of a running stream, in such a manner that a slender stream, about an inch deep, may flow gently through it. We thus obtain a kind of artificial rivulet, protected from all invasion from without. The fecundated ova of the salmon are then placed upon the gravel, the case is closed, and from time to time care is taken to clean the ova by agitating the water slightly with a feather to remove the least deposit of mud, which, by adhering to their surface, might interfere with the success of the operation. In about thirty or forty days, according to the temperature, the young salmon issue from the egg; they live for some time in the box, and then leave it for the adjoining rivulet, which ought to lead to a fish-preserve or pond. If the latter is conveniently arranged, the young salmon remain there and acquire their ulterior development. Count de Golstein assures us that he obtained, by a single experiment, 430 salmon, and that they enabled him to stock several fish-ponds. It will easily be seen that this same process may be applied to the rearing of all kinds of fresh-water fishes.

If I am not deceived, we have here the necessary hints to give birth to a kind of economy altogether new, at least, in France. Young salmon live very well in fresh water till the age of two or three years; at this period, they have reached a length of from 35 to 40 centimetres, and are much esteemed on account of the delicacy of their flesh. These facts, well known in Scotland, have led many to attempt to discover the means of inducing salmon to spawn in fish-ponds where the young may be reared for sale. This end has been attained by forming canals of running water which terminate in the great rivers ascended by salmon. By means of works, often very expensive, cascades, too high to be surmounted, have been broken down into falls which these fishes can easily ascend. By combining these various means, salmon have been conducted into countries to which they never before penetrated, and even into basins prepared to facilitate the development of the young. Artificial fecundations, and transporting young salmon hatched near fisheries, would render all these preliminary expenses unnecessary, and allow

the rearing of these fishes even in localities very remote from those to which salmon naturally resort when they leave the sea for fresh waters.

In fact, it is not even necessary, for the success of fecundation, that the fishes employed should be alive. M. de Golstein has fecundated the ova of a trout which had been four days dead, with entire success. It is probable that the fecundating liquid likewise preserves its properties long after the death of the males. This is, at all events, a fact which I have often verified in regard to invertebrata. Moreover, young fishes, after they are hatched, are nourished, for a pretty long period, at the expense of the vitelline substance enclosed in their intestines. Salmon, in particular, appear to have no need of other nutriment till the end of a month or six weeks. It will be seen that, to the other advantages presented by the process of which we speak, we must join that of facilitating the dissemination of species. Our rivers, ponds, and lakes, may easily be enriched with species valuable for the delicacy of their flesh, or for their great fecundity. Attempts have rarely been made to naturalise foreign fishes, and yet the success of some trials ought to have encouraged experimenters. The Gourami of China has been naturalised in the ponds of the Isle of France, and afterwards in Cayenne. China has furnished us with the gold fishes (*Cyprinus auratus*) so common in our ponds. The carp itself, now spread throughout Europe, very probably came from Persia. First introduced into the south of Europe, it was not till the middle ages that it penetrated into Prussia, and that country has now made it a considerable article of commerce. It was not till the sixteenth century that it was imported into England and Denmark; later still into Sweden and Russia, and although it loses somewhat in size, it bears the rigorous winters of these countries very well. The employment of artificial fecundation, applied and perfected by experience, would certainly one day give an entirely new importance to the management of ponds, and render a produce, which is now necessarily irregular and, at most, triennial, an annual produce. It is well known that a rest of three years, at least, is necessary before a pond that has been fished can be repeopled. This is a great inconvenience; in order to remedy it, it would be necessary to divide the pond into three or four compartments of unequal size, communicating with each other by means of sluices. The smallest of these compartments should be arranged for hatching the ova and rearing the fry; every year the fishes might be driven from one compartment into the other, until they reach the last, which might thus be fished to the bottom every year, and immediately re-stocked by individuals from the next compartment. Reserves placed at the sides would enable us, moreover, to preserve fishes which we wished to become old.—(*L'Institut*, 8th November 1848, p. 342.)

9. *On Electric Fishes*.—M. R. Wagner has laid before the Academy of Sciences, an extract from his new researches on electric fishes.

Since his first investigation on this subject, the author has studied a greater number of electrical fishes, and has directed his attention particularly to their nervous system, more especially of the brain. He has endeavoured to determine anatomically whether there was in the general structure a certain central organ (a ganglionic mass) combined with the brain and spinal marrow, in which the nerves of the electric organ might originate, or whether the ganglionic substance necessary to this structure, instead of being apparent to the eye, may not be often merged in different parts of the interior of the brain or spinal marrow. He has endeavoured to ascertain, in the second place, whether, in the first general case, the original plan of the structure of the brain, which, among vertebrates, evidently presents the most simple form, undergoes any modification by the appearance of these accessory ganglions, or whether these organs are connected with the general plan, or whether they constitute an ulterior development of the already existing portions of the brain.

The author's observations refer to *Torpilla*, the *Narcine*, *Gymnotus electricus*, and the electrical *Malapterus* of the Nile, and it appears to result from them, both in a morphological and in a physiological point of view, that it is extremely doubtful whether the brain be the seat of a nervous centre for the electrical apparatus; he rather thinks that this centre exists either in the medulla oblongata, or in the spinal marrow.

10. *Dr J. Y. Simpson on the "Effects of Chloroform on Lower Animals":—*

(1.) In animals belonging to the class *Articulata*, complete local and limited anæsthesia can be produced by the local and limited application of the vapour or liquid of chloroform to individual parts of the body of the animal.

(2.) In *Batrachian Reptiles*, the tail, or an individual limb, can be affected in the same way with local anæsthesia, by the local application of the chloroform; but, in addition, general anæsthesia of the animals usually results in a short time, in consequence of the chloroform absorbed by the exposed part coming to affect the general system.

(3.) In the *smaller Mammalia* a single limb, or even the whole lower or pelvic half of the body, can be rendered anæsthetic by local exposure of these parts to the influence of chloroform.

11. *Effects of Local Anæsthesia on the Human Body:—*

(1.) In the human subject, partial, and perhaps superficial, local anæsthesia of a part, as the hand, can be produced by exposing it to the strong vapour of chloroform; but the resulting degree of this local anæsthesia is not sufficiently deep to allow the part to be cut or operated upon without pain.

(2.) Any agent possessing a stronger local benumbing or an anæsthetic influence, would probably be dangerous, by its acting too powerfully on the general economy, before the local anæsthesia was established to a depth sufficient for operating.

(3.) Artificial local anæsthesia, from any known anæsthetic agent, seems objectionable in any part intended to be operated upon, in consequence of the vascular congestion and injection which attend upon and accompany this local anæsthesia.

(4.) There are few operations in which there is not previously a local broken surface; and the application of chloroform, &c., to such a surface, would be far too painful to be endured; no small degree of suffering sometimes arising from even the exposure of the unbroken skin to their action.—(*From Notes on Local Anæsthesia, by Dr J. Y. Simpson.*)

12. *Effect of Low Temperature on Raw Flesh as an article of Food.*—The fishmarket, says M. Erman, was plentifully supplied. We particularly remarked a species of salmon, unknown in Europe, and called here the Nelma (*Salmo Leucichthys*, *Güldenstädt*; *S. nelma*, *Pallas*), and great quantities of the roe in wooden vessels. This is white and small in grain, and sold fresh; it is not salted till required for use. These roes and thin slices of the flesh are deemed by the Russians more delicious when raw than cooked, and are eaten as provocatives of appetite. Later experience taught us how much the influence of the cold tends to favour the adoption of raw animal food; so much so, that it hardly requires the addition of salt—in fact, during the intense frost, the raw flesh even of warm-blooded animals loses its repulsive qualities.—(*Erman's Travels in Siberia*, vol. i., p. 309.)

13. *The Prevention of the Bed Bug (Cimex lectularius).*—Mr Thomas Stratton, in reference to letters on the prevention of the bed bug (*Cimex lectularius*), says,—“I have used Sir W. Burnett's disinfecting fluid, the solution of the chloride of zinc; it was applied by means of a feather, to all the joints and crevices in the bedstead, and with complete success. The solution entering the wood rendered it an unfit, and probably a poisonous habitation for the *Cimex*.”

The prevention of these animals is of more importance than some may at first suppose it be: In some severe diseases the disturbance they give the patient may greatly impede recovery, and I have heard of instances where soldiers in barracks, finding sleep impossible in bed, have gone out of doors, and, sleeping there, have been seized with inflammation of the lungs, or other diseases, dangerous, and sometimes fatal.—*Annals of Natural History*, Ser. 2, vol. iii., p. 78.

14. *Supposed Boring Powers of the Echinus lividus.*—Having lately had an opportunity of inspecting *in situ* at Kilkee, on the coast of Clare (Ireland), the curious *Echinus lividus* of Lamarck, about whose boring powers much has been said and written, I have, after many observations, come to the conclusion that the animal does not possess any power, chemical or mechanical, of boring into rocks. This *Echinus* instinctively seeks for the most sheltered situations, either in an angle between two rocks, or in depressions resulting from the disintegration of the rock, which in limestone are often

very numerous and deep. Very young individuals I have several times found comfortably ensconced in deserted limpet or other shells. The bottom and sides of the cavities occupied by the Echinus become in time smoothed and deepened, more particularly in limestone; but this I am convinced is not the effect of instinctive action, chemical or mechanical, nor of the locomotion of any one individual, but of that of countless generations which have successively inhabited the spots during the lapse of ages, and have thus gradually worn the stone away, and produced the remarkable appearances as of regularly bored holes, the depth of which is in many cases increased by the growth of the common millepora around them.—(W. C. Trevelyan.)

BOTANY.

15. *Observations on Manna.* By J. Stettner (*Chemical Gazette*, July 1848, No. 137, p. 261; *Archiv der Pharm.*, vol. liii., p. 194). The author gives the following account of the cultivation of the manna ash, and the collection of the manna, from observations made in Sicily during the summer 1847. The manna ash, *Fraxinus ornus*, in the manna districts of Capace, Cinesi, and Fabarotto, where the best manna is obtained, does not form woods, as is generally supposed, but is cultivated in separate plantations. These plantations generally form regular squares, hedged in with *Cactus opuntia*. The trees are planted in rows, and are from 2 to 8 inches in diameter, with stems from 10 to 25 feet high, which from the first shoot are kept smooth and clean. The soil is carefully loosened, and kept free from weeds. After the eighth year the trees yield manna, which they then continue to do from ten to twelve years, when they are cut down, and young shoots from the roots trained; one root stock frequently yields from six to eight new trees and more. For the production of the manna, young and strong shoots are requisite; but they are not tapped before the tree ceases to push forth any more leaves, and the sap consequently collects in the stem. This period is recognised by the cultivators from the appearance of the leaves; sometimes it occurs earlier than at others, and the collection of the manna takes place either at the beginning of July or only in August. Close to the soil cross sections are made in the stem, and in the lowermost sections small leaves are inserted, which conduct the sap into a receptacle formed by a cactus leaf: this is the way the manna *in sorte* is obtained. The incisions are repeated daily in dry weather, and the longer this continues the more manna is obtained. The stems are left uninjured on one side, so that the manna runs down the smooth bark more easily. The next year the uninjured side is cut. The *Manna cannelata* is obtained from the upper incisions, more than forty of which may be counted on one tree. The sap is there not so fat as below, and consequently dries more easily into tubes and flat pieces. After the manna has been removed from the trees, it has further to be dried upon the shelves, before being packed

in cases. The masses left adhering to the stems, after removing the inserted leaves, are scraped off, and constitute the *Manna cannellata in fragmentis*; *Cannellata*, *Cun. in fragm.*, and *Capace* are collected at the same time from one stem; the more *Cannellata*, the younger, and the more *Capace* or *Gerace*, the older the stem. In Sicily the latter is designated *in sorte*, and is probably the most active. Dry and warm weather is essentially requisite for a good harvest.

MISCELLANEOUS.

16. *Port Natal*.—The future prospects of the district of Natal, as a colony, depend very materially, if not exclusively, upon the filling up of the unoccupied intervals of the district with emigrants from the United Kingdom. Its general capabilities, as we have already represented, are of the highest class, either for agricultural or grazing purposes. It contains an area of 18,000 square miles, within which is found every material for improvement and prosperity a colony can be favoured with, and requires but an intelligent white population to develop its immense and fertile resources. Building stone of a very good quality is found all over its surface; and in some localities a superior description of freestone is found in abundance. Iron ore is found in great abundance in the district, and it is said to be of very superior quality. The prices realised in England for the first exportation of cotton grown in this district, exhibited under all the disadvantageous circumstances connected with utter inexperience on the part of the grower, of sevenpence farthing per pound, warrants an inference highly favourable to the quality of the article, when it shall have received the treatment that experience has taught to be necessary in cotton-growing countries. The district everywhere is covered with vegetation, either in the form of luxuriant grass, which grows to a great height, or thorns and low bushes. Timber trees only grow in kloofs on sides of hills, excepting a belt which runs along the sea-coast. Water abounds in every part, and flowing streams cross the path at intervals of only a few miles. In winter some of these become dry, but then water may always be obtained at moderate distances. The soil is, in all cases, well adapted for cultivation; and on the alluvial lands, near rivers, particularly so, producing much larger crops than are ever grown in the colony of the Cape of Good Hope. Sandstone and shale are the prevailing rocks in the northern portion of this district. The sandstone which forms the hills immediately to the north-west of Pieter Maritzburg, is an excellent building stone, which works well under the chisel, and can be obtained in large masses. Coal, containing but little bituminous matter, occurs in beds in the sandstone. In a kloof near the drift of the Bushman's River, there is a thick bed of good quality. —*Dr Stanger, Surveyor-General.*

*List of Patents granted for Scotland from 22d December 1848,
to 22d March 1849.*

1. To STEPHEN TAYLOR, of Ludgate Hill, in the city of London, gentleman, "certain improvements in the construction of fire-arms, and in cartridges for charging the same," being a communication from abroad.—26th December 1848.

2. GEORGE FERGUSSON WILSON, of Belmont, Vauxhall, in the county of Surrey, gentleman, and CHARLES HUMPHREY, of Manor Street, Old Kent Road, in the said county of Surrey, merchant, "improvements in the production of light by burning oleic acid in lamps, and in the construction of lamps, and manufacture or preparation of oleic acid for that purpose."—28th December 1848.

3. To WILLIAM GILMOUR WILSON, of Port-Dundas, Glasgow, engineer, "improvements in the formation of moulds and cores of moulds for casting iron and other substances."—4th January 1849.

4. ROBERT ANGUS SMITH, of Manchester, "improvements in the application and preparation of coal-tar."—4th January 1849.

5. EDWARD SCHUNCH, of Rochdale, in the county of Lancaster, chemist, "improvements in the manufacture of malleable iron, and in treating other products obtained in the process."—8th January 1849.

6. To JOHN MITCHELL, chemist, HENRY ALDERSON, civil-engineer, and THOMAS WARRINER, farmer, of Lyons Wharf, Upper Fore Street, Lambeth, in the county of Surrey, "improvements in smelting copper."—10th January 1849.

7. To JOHN WRIGHT, of Camberwell, in the county of Surrey, engineer, "improvements in generating steam and evaporating fluids."—10th January 1849.

8. To DAVID YOOLOW STEWART, of Montrose, in the kingdom of Scotland, iron-founder, "improvements in the manufacture of moulds and cores of moulds for casting iron and other substances."—10th January 1849.

9. To RICHARD ROBERTS, of the Globe Works, Manchester, in the county of Lancaster, "certain improvements in, and applicable to clocks, and other time-keepers in machinery, or apparatus for winding clocks and hoisting weights, and for effecting telegraphic communication between distant clocks and places, otherwise than by electro-magnetism."—11th January 1849.

10. To EDWARD SLAUGHTER, of the Avonside Iron-Works, Bristol, engineer, "improvements in marine steam-engines."—12th January 1849.

11. To ISRAEL KINSMAN, late of New York, but now of Ludgate Hill, in the city of London, "improvements in the construction of rotary-engines, to be worked by steam or other elastic fluid," being a communication from abroad.—12th January 1849.

12. To EDWARD SMITH, of Kentish Town, in the county of Middlesex, blind-manufacturer, "improvements in window-blinds, and in springs, applicable to window-blinds, doors, and other like purposes."—16th January 1849.

13. To ANDREW LAMB, of Southampton, in the county of Hants, engineer, and WILLIAM ALLTOFT SUMMERS, of Millbrook, in the county of Southampton, engineer, "improvements in steam-engines and steam-boilers, and in certain apparatus connected therewith."—16th January 1849.

14. To WILLIAM EDWARD NEWTON, of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, "improvements in the construction of stoves, grates, furnaces, or fire-places, for various useful purposes," being a communication from a certain foreigner residing abroad.—16th January 1849.

15. To JAMES HAMILTON, of London, civil engineer, "improvements in cutting wood."—17th January 1849.

16. To ANDREW SHANKS, of Robert Street, Adelphi, in the county of Middlesex, engineer, "an improved mode of giving form to certain metals when in a fluid or molten state."—17th January 1849.

17. To JAMES YOUNG, of Manchester, in the county of Lancaster, manufacturing chemist, "improvements in the preparation of certain materials used in dyeing and printing."—19th January 1849.

18. To WILLIAM MARTIN, of St Pierre Les Calais, in the republic of France, machinist, "certain improvements in machinery for figuring textile fabrics, parts of which improvements are applicable to playing certain musical instruments, and to printing, and other like purposes."—24th January 1849.

19. To JOSEPH DEELEY, of Newport, in the county of Monmouth, engineer and iron-founder, "improvements in ovens and in furnaces."—24th January 1849.

20. To LAWRENCE HILL, jun., of Motherwell Iron-Works, near Hamilton, Lanarkshire, civil engineer, "improvements in the manufacture of iron, and in the machinery for producing the same," being a communication from HENRY BURDEN, of Troy, in the U. S. of America.—31st January 1849.

21. To ALEXANDER PARKES and HENRY PARKES, of Birmingham, "improvements in the manufacture of metals, and alloying of metals, and in the treatment of metallic matters with various substances."—31st January 1849.

22. To FRANCIS HAY THOMSON, of Hope Street, in the city of Glasgow, North Britain, M.D., "an improvement, or improvements, in smelting copper or other ores."—2d February 1849.

23. To EWALD REIPE, of Finsbury Square, in the county of Middlesex, merchant, "improvements in the manufacture of soap," being partly a communication from ANTOIN LOHAGE, residing abroad.—5th February 1849.

24. To DAVID NAPIER and JAMES MURDOCK NAPIER, of the York Road, Lambeth, in the county of Surrey, engineers, "certain improvements in mariners' compasses, also in barometers, and in certain other measuring instruments."—5th February 1849.

25. To REES REECE, of London, chemist, "improvements in treating peat, and obtaining products therefrom."—5th February 1849.

26. To EDMUND GEORGE PINCHBECK, of Fleet Street, in the city of London, "improvements in certain parts of steam-engines."—5th February 1849.

27. To JAMES ROBERTSON, of Great Howard Street, Liverpool, in the county of Lancaster, cooper, "improvements in the manufacture of casks and other wooden vessels, and in machinery for cutting wood for these purposes."—5th February 1849.

28. To ACHILLE CHANDOIS, of Paris, in the republic of France, manufacturing chemist, "improvements in extracting and preparing the colouring matter from orchil."—7th February 1849.

29. To TENNET ALLMAN, of 18 Charles Street, Saint James' Square, Westminster, consulting engineer, "improvements in apparatus for the production of light from electricity."—7th February 1849.

30. THOMAS DE LA RUE, of Bunhill Row, in the county of Middlesex, manufacturer, "improvements in producing ornamental surfaces to paper and other substances."—9th February 1849.

31. To JONAH DAVIES and GEORGE DAVIES, of the Albion Iron-Foundry, in the parish of Tipton, Staffordshire, iron-founder, "improvements in steam-engines."—9th February 1849.

32. To SAMUEL BROWN, the younger, of Lambeth, in the county of Surrey, engineer, "improved apparatuses for measuring and registering the flow of liquids, and of substances in a running state, which apparatuses are, in part, also applicable to other useful purposes."—12th February 1849.

33. HUGH BELL, of London, Esquire, "certain improvements in aerial machines and machinery, in connection with the buoyant power produced by gaseous matter."—19th February 1849.

34. To JAMES BAIRD, of Gartsherrie, in the parish of Old Monkland, in the county of Lanark, in Scotland, iron-master, and ALEXANDER WHITELAW, of Gartsherrie Iron-Works, parish and county aforesaid, manager of said works, "improvements in the method or process of manufacturing."—23d February 1849.

35. EMANUEL MILLER, of Baltimore, Maryland, in the United States of America, gentleman, "certain improvements in dressing or cleaning grain, and in separating extraneous matters therefrom."—21st February 1849.

36. To WILLIAM CLAY, of Clefton Lodge, in the county of Cumberland, engineer, "certain improvements in machinery for rolling iron or other metals, parts of which improvements are applicable to other machinery in which cylinders or rollers are used."—19th February 1849.

37. To CAREY McCLELLAN, of Larch Mount, in the liberties of the city of Londonderry, "an improved corn-mill."—20th February 1849.

38. To SAMUEL WELLMAN WRIGHT, of Chalford, in the county of Gloucester, civil engineer, "certain improvements in preparing various fibrous substances for spinning, and in machinery and apparatus connected therewith."—27th February 1849.

39. To MICHAEL LOAM, of Treskerley, in the parish of Gwennap, in the county of Cornwall, engineer, "improvements in the manufacture of forges."—28th February 1849.

40. To ROBERT JOBSON, of Holly Hall works, near Dudley, in the county of Stafford, "improvements in the manufacture of stoves."—5th March 1849.

41. To WILLIAM EDWARD NEWTON, of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, "a certain improvement or improvements in the construction of wheels," being a communication from abroad.—5th March 1849.

42. To JOHN SMITH of Hare, Craig, Dundee, factor to Lord Douglas, of Douglas, "improvements in the manufacture of flour applicable in the making of bread, biscuits, or pastry."—6th March 1849.

43. To WILLIAM EDWARDS STAITE, of Throgmorton Street, in the city of London, civil engineer, "improvements in the construction of galvanic batteries in the formation of magnets, and in the application of electricity and magnetism, for the purpose of lighting and signalling, as also a mode or modes of employing the said galvanic batteries, or some of them, for the purpose of obtaining chemical products."—7th March 1849.

44. CHARLES THOMAS PEARCE, of Park Road, Regent's Park, in the county of Middlesex, Esquire, "improvements in apparatus for obtaining light by electric agency."—7th March 1849.

45. To RICHARD LAMING, of Clichy-la-Garenne, in the republic of France, chemist, "improvements in the modes of obtaining or manufacturing sulphuric acid, partly his own invention, and partly a communication from abroad."—9th March 1849.

46. To GEORGE NASMYTH, of Great George Street, in the city of Westminster, "certain improvements in the construction of fire-proof flooring and roofing, which improvements are also applicable to the construction of viaducts, aqueducts, and culverists."—12th March 1849.

47. To THOMAS HENRY RUSSELL, of Wednesbury, patent tube-manufacturer, and JOHN STEPHEN, Woolrich, of Birmingham, chemist, "improvements in coating iron, and certain other metals and alloys of metals."—13th March 1849.

48. To GEORGE FERGUSSON WILSON, of Bellmont, Vauxhall, gentleman, "improvements in separating the more liquid parts from the more solid parts of fatty and oily matters, and in separating fatty and oily matters from foreign matters, and in the manufacture of candles and night-lights."—13th March 1849.

49. To CHARLES ROBERT COLLINS, of Brunswick Street, in the city of Glasgow, North Britain, paper-manufacturer, "a certain improvement or improvements in the manufacture of paper."—14th March 1849.

50. JOHN HICK, of Bolton-le-Moors, in the county of Lancaster, engineer, and WILLIAM HODGSON GRATRIX, of Salford, in the county of Lancaster, engineer, "certain improvements in steam-engines, which improvements are more particularly applicable to marine engines, and also improvements in machinery or apparatus for propelling vessels."—16th March 1849.

51. To WILLIAM EDWARD NEWTON, of the office for patents, 66 Chancery Lane, in the county of Middlesex, civil engineer, "improvements in engines or apparatus principally designed for pumping water," being a communication from abroad.—19th March 1849.

52. To WILLIAM GALLOWAY and JOHN GALLOWAY, of Knott Mill Iron-Works, Hulme, in the burgh of Manchester, and county of Lancaster, engineers, "certain improvements in steam-engines."—22d February 1849.

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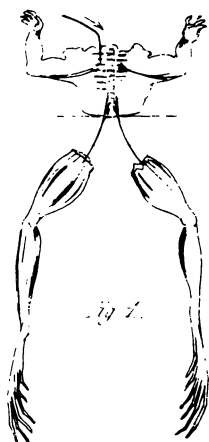


Fig. 1.

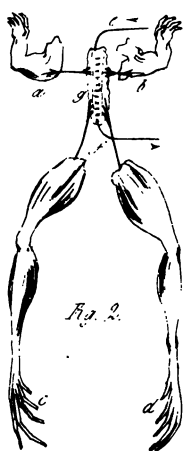


Fig. 2.



Fig. 3.



Fig. 4.

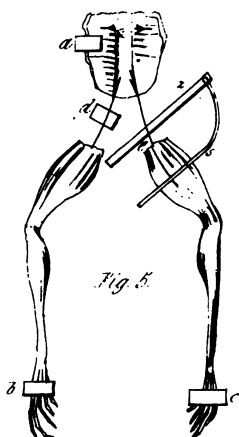


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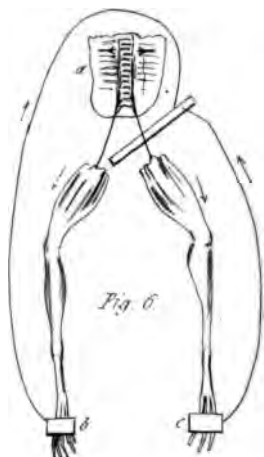


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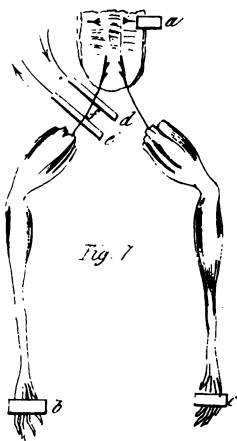


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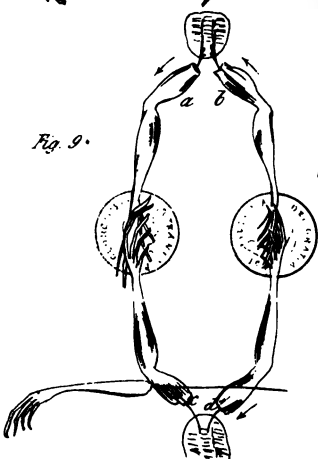


Fig. 9.



Fig. 8.

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F. Schenk Lith. E. Schenk

W. H. Zimmer

Fig. 1. Versailles railway.

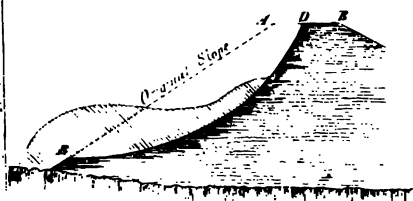


Fig. 3



Fig. 2. Reservoir of Lyons (Surgundy).



Fig. 5



Figure 4.

1 The new fluid spreading.



2 It gains a head



3 A new head forms, head lowers



4 A new head forms.



5 A second spread.



Sketch of a Shaving of Malleable Iron
Showing planes of destruction

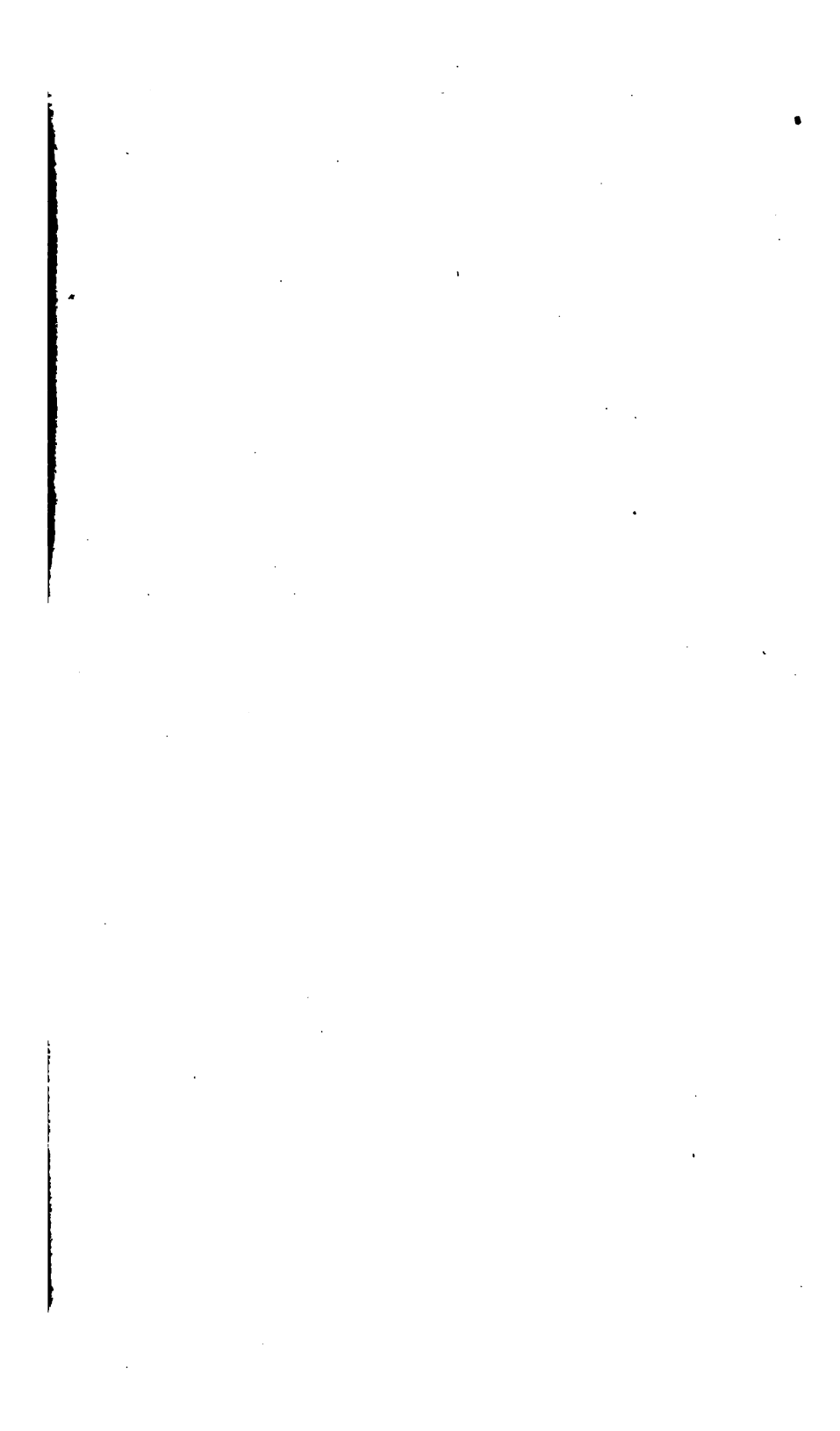


Fig. 6.

Fig. 7. The Shaving developed.







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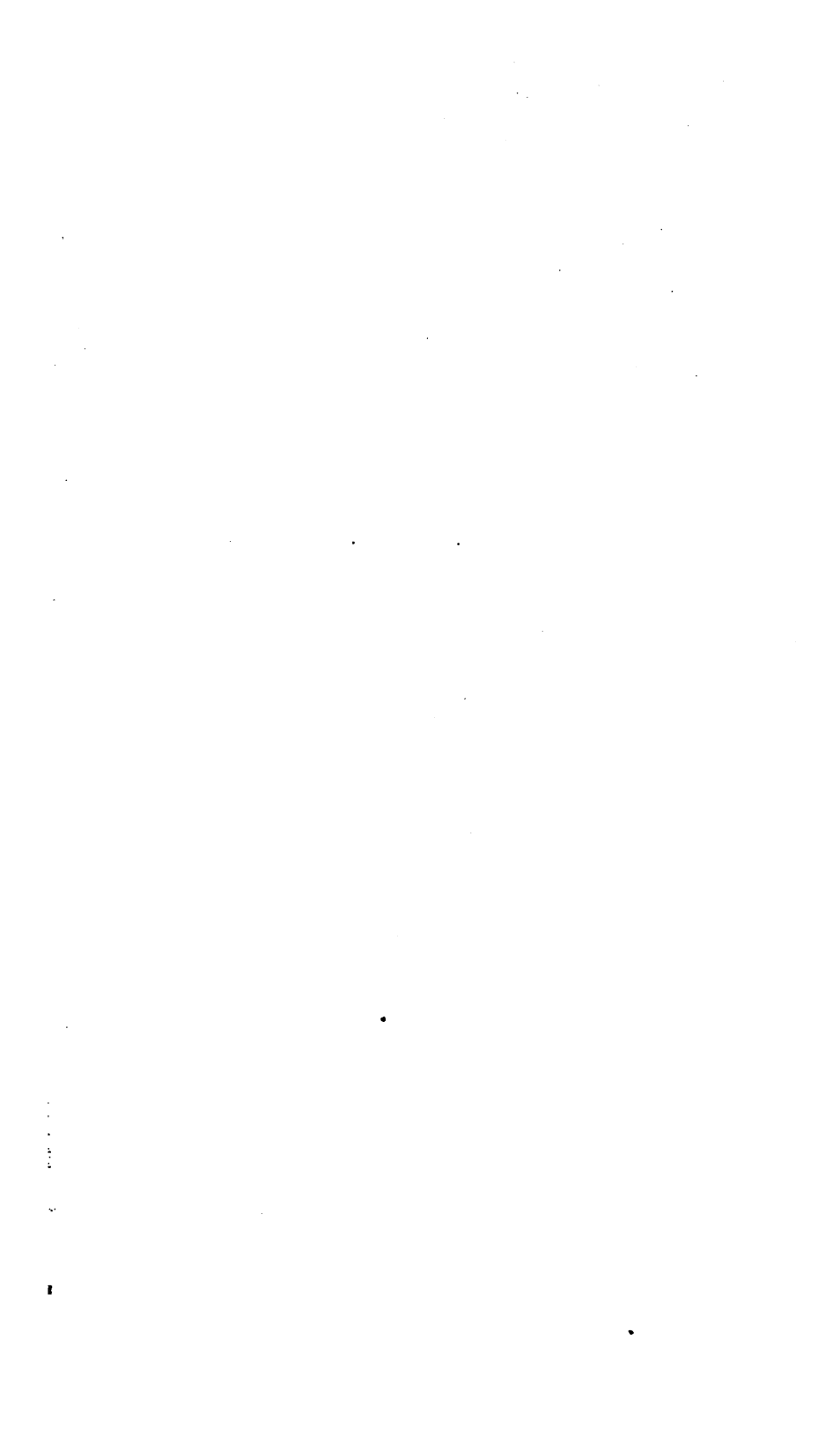
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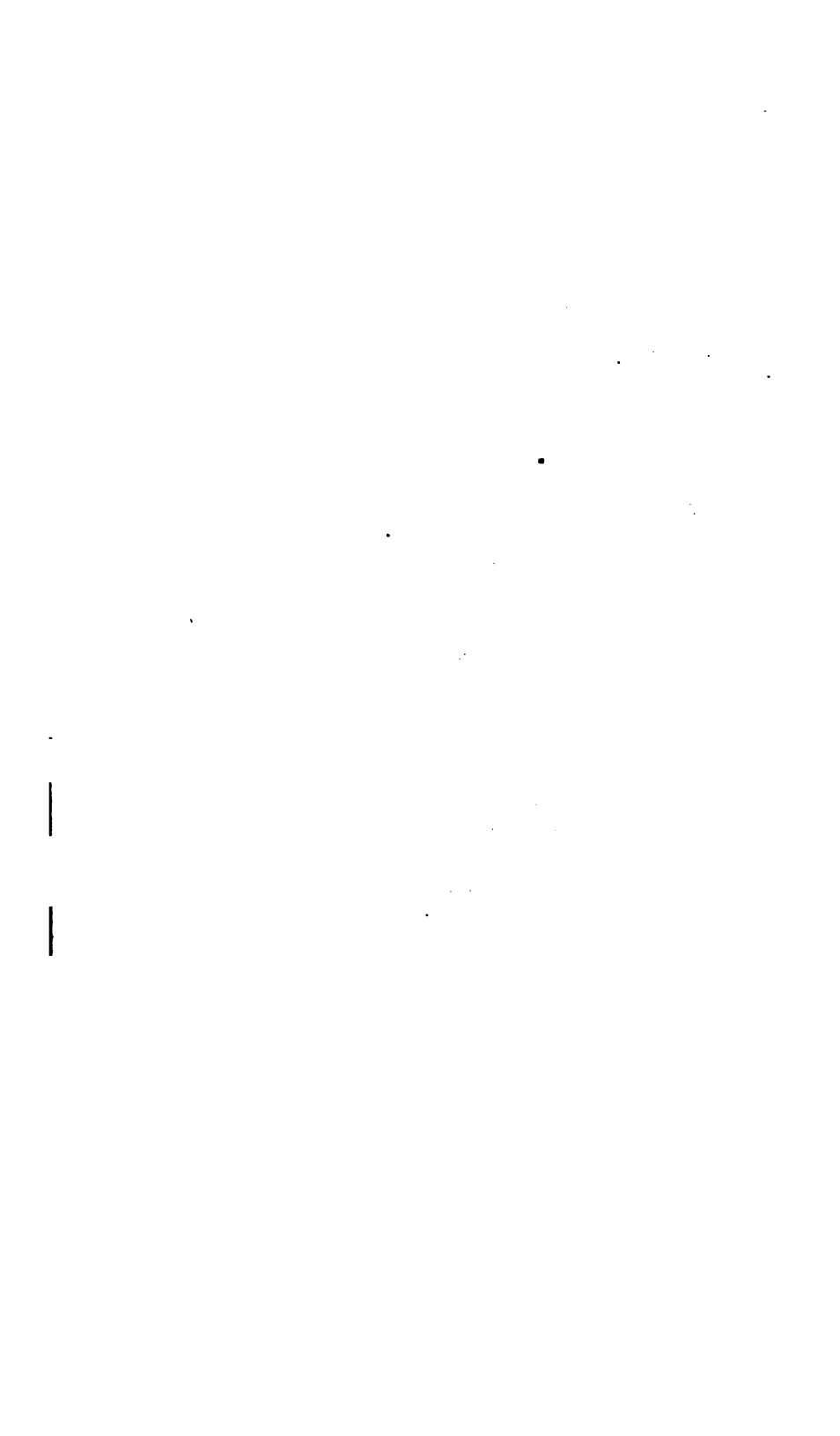
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